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A Simulation Study of the Flight Dynamics of Elastic Aircraft

Volume Two—Data

Martin R. Waszak, John B. Davidson,
and David K. Schmidt

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LIST OF SYMBOLS

Symbol	Meaning
$C_{(\cdot)}$	aerodynamic coefficient for the parameter $(\cdot)$
F_{pitch}, F_{roll}, F_s	stick input forces, lbs
I_{xx}, I_{yy}, etc.	mass moments of inertia, slug-ft^2
$K_{(\cdot)}$	control gains
$\underline{L}$	aerodynamic rolling moment in body axes, ft-lbs
M	Mach number and vehicle mass, slugs
$\underline{M}$	aerodynamic pitching moment in body axes, ft-lbs
$\mathcal{M}_y$	generalized modal mass for antisymmetric mode, slug-ft^2
$\mathcal{M}_z$	generalized modal mass for symmetric modes, slug-ft^2
$\underline{N}$	aerodynamic yawing moment in body axes, ft-lbs
P_ε	longitudinal tracking error, degrees
Q_{η_y}	generalized force for antisymmetric mode, ft-lbs
Q_{η_z}	generalized force for symmetric mode, ft-lbs
R_ε	lateral tracking error, degrees
S	wing planform area, ft^2
T	total vehicle thrust force, lbs
U, V, W	velocity components of vehicle body axes, ft/sec
$\underline{W}$	vehicle weight, lbs
V_{TOT}	total velocity, ft/sec
V_0	trim velocity, ft/sec
X, Y, Z	aerodynamic force components in body axes, lbs
$a_{n_{(\cdot)}}$, $a_{y_{(\cdot)}}$	normal and lateral accelerations, g's
b	wing span, ft
$\bar{c}$	mean aerodynamic chord, ft
g	gravitational acceleration, ft/sec^2
h	altitude, ft
l_{cp}	distance from cg to cockpit in x-direction, ft
$n_{z_{(\cdot)}}$, $n_{y_{(\cdot)}}$	normal and lateral accelerations, g's

Symbol	Meaning
p	roll rate of vehicle body axes, rad/sec
q	pitch rate of vehicle body axes, rad/sec
q_M	pitch rate of the ideal body-reference (mean) axes, rad/sec
q_T	total pitch rate measured at cockpit location, rad/sec
r	yaw rate of vehicle body axes, rad/sec
s	Laplace variable
t	time, sec
x, y, z	coordinate directions of the vehicle body axes
z_{cp}	distance from cg to cockpit in negative z-direction, ft
Λ	wing sweep, degrees
Φ_{cp}^{y}	modal displacement at cockpit in y-direction, ft
Φ_{cp}^{z}	modal displacement at cockpit in z-direction, ft
Φ_{cp}^{ϕ}	fuselage torsional displacement mode shape at cockpit, rad
α	angle of attack, degrees
β	sideslip angle, degrees
γ	flight path angle, degrees
δ_{cv}	forward control vane deflection, degrees
δ_{long}, δ_{lat}	longitudinal and lateral stick deflections, inches
δ_p	pilot stick input, inches
δ_{ped}	rudder pedal deflection, inches
δ_{RL}, δ_{RU}	lower and upper split rudder deflections, degrees
δ_{DH}	differential horizontal tail deflection, degrees
δ_t	symmetric horizontal tail deflection, degrees
δ_S	spoiler deflection, degrees (right spoiler positive)
$\varepsilon_{(\cdot)}$	tracking errors
ζ_y, ζ_z	antisymmetric and symmetric modal damping ratios
η_y	antisymmetric generalized modal coordinate, ft
η_z	symmetric generalized modal coordinate, ft
η_1, η_2	random variables to drive command signals
ρ	atmospheric density, slug/ft^3

Symbol	Meaning
$\sigma_{(\cdot)}^2$	variance of parameter $(\cdot)$
$\tau_{(\cdot)}$	time delay and time constant, sec
ϕ, θ, ψ	standard Euler angles
ω	frequency, rad/sec
ω_y	invacuo vibration frequency of antisymmetric mode, rad/sec
ω_z	invacuo vibration frequency of symmetric mode, rad/sec
ω_θ, ω_ϕ	corner frequencies of tracking command filter, rad/sec

subscripts

C	commanded
D	displayed
ERROR	error
TOT	total
TRIM	trim
c, cmd, com	commanded
cg	center of gravity
cp	cockpit
n	normal
p	pitch
r	roll
y	antisymmetric mode and lateral direction
z	symmetric mode
γ	flight path
ε	error
θ	pitch
ϕ	roll
ψ	yaw

Symbol	Meaning

operations

$\hat{(\cdot)}$ .... measured response of $(\cdot)$
$\dot{(\cdot)}$ .... time derivative of $(\cdot)$
$|\cdot|$ .... magnitude of $(\cdot)$

abbreviations

AGT .... Adage Graphics Terminal
A/D .... Analogue-to-Digital Converter
CRT .... Cathode Ray Tube
D/A .... Digital-to-Analogue Converter
ESC .... Eigenspace Assignment Controller
ETAY .... lateral axis structural mode status
ETAZ .... longitudinal axis structural mode status
FNE .... engine thrust parameter
KQ .... gain on pitch-rate feedback in SCAS
OMEGAY .... antisymmetric mode frequency
OMEGAZ .... symmetric mode frequency
PLA .... Power Lever Angle
RMS .... Root-Mean-Square
SCAS .... Stability and Control Augmentation System
SPDH .... Speed Hold (Phugoid Augmentation Controller)
THCINC .... thrust increment
THCDEC .... thrust decrement
VMS .... Langley Visual/Motion Simulator

ABSTRACT

The simulation experiment described herein addresses the effects of structural flexibility on the dynamic characteristics of a generic family of aircraft. The simulation was performed using the NASA Langley Visual/Motion Simulator facility. The vehicle models were obtained as part of this research project. The simulation results include complete response data and subjective pilot ratings and comments and so allow a variety of analyses. The subjective ratings and analysis of the time histories indicate that increased flexibility can lead to increased tracking errors, degraded handling qualities, and changes in the frequency content of the pilot inputs. These results, furthermore, are significantly affected by the visual cues available to the pilot.

APPENDICES

Appendix 1
Aerodynamic Data

This appendix consists of the aerodynamic force and moment coefficients and generalized force and moment coefficients for the elastic vehicle model. These nondimensional coefficients are tabulated for various values of vehicle angle on attack, α in degrees. The coefficients that are tabulated correspond to the coefficients which appear in the table of aerodynamic forces and moments, Table 2 in Chapter 2. The values of the coefficients correspond to the forces and moments that occur for the geometry, mass and inertia, and flight condition of the baseline study vehicle.

Table A.1 - Aerodynamic Force Data

ALPHA	C_x	C_{x_q}	$C_{x\delta_s}$	$C_{x\delta_t}$	$C_{x\delta_{cv}}$
-10	0.010	1.0	-0.0003	0.0042	0.0006
-5	-0.013	0	-0.0003	0.0032	
0	-0.028	-2.0	-0.0005	0.0027	
5	0.020	1.0	-0.0007	0.0024	
7.5	0.030	5.0	-0.0006	0.0016	
10	0.008	7.	-0.0002	0.0012	
12.5	-0.002	6.5	0.0001	0.0018	
15	-0.008	4.0	0.0001	0.0018	
17.5	-0.013	2.0	0.0001	0.0016	
20	-0.015	1.0	0.0001	0.0012	

ALPHA	C_{y_β}	$C_{y\delta_s}$	$C_{y\delta_{DH}}$	$C_{y\delta_{RU}}$	$C_{y\delta_{RL}}$	$C_{y\eta_y}$	$C_{y\dot{\eta}_y}$
-10	-0.0131	-0.00020	-0.0006	0.00292	0.00128	-0.0090	-0.016
-5	-0.0130	-0.00020	-0.0005	0.00227	0.00113	-0.0090	-0.016
0	-0.0110	-0.00020	-0.0005	0.00187	0.00103	-0.009	-0.016
5	-0.0100	-0.00020	-0.0005	0.00147	0.00103	-0.009	-0.016
7.5	-0.0100	-0.0020	-0.0004	0.00157	0.00103	-0.009	-0.016
10	-0.0100	-0.00020	-0.0002	0.00167	0.00103	-0.009	-0.016
12.5	-0.0100	-0.00016	-0.0003	0.00177	0.00103	-0.009	-0.016
15	-0.0100	-0.00010	-0.0004	0.00177	0.00103	-0.009	-0.016
17.5	-0.0090	-0.00007	-0.0004	0.00177	0.00103	-0.009	-0.016
20	-0.0080	0	-0.0003	0.00177	0.00103	-0.009	-0.016

ALPHA	C_z	C_{z_q}	$C_{z\delta_s}$	$C_{z\delta_t}$	$C_{z\eta_z}$	$C_{z\dot{\eta}_z}$	$C_{z\delta_{cv}}$
-10	0.14	-10.0	0.0036	-0.0058	-0.0288	-0.0848	-0.0016
-5	-0.09	18.0	0.0036	-0.0066	-0.0288	-0.0848	
0	-0.34	18.0	0.0036	-0.0078	-0.0288	-0.0848	
5	-0.60	-15.0	0.0036	-0.0061	-0.0288	-0.0848	
7.5	-0.66	-37.0	0.0030	-0.0040	-0.0288	-0.0848	
10	-0.66	-55.0	0.0016	-0.0021	-0.0288	-0.0848	
12.5	-0.70	-51.0	0.0008	-0.0010	-0.0288	-0.0848	
15	-0.73	-50.0	0.0003	-0.0003	-0.0288	-0.0848	
17.5	-0.73	-40.0	0	-0.0012	-0.0288	-0.0848	
20	-0.73	-35.0	0	-0.0028	-0.0288	-0.0848	

Table A.2 - Aerodynamic Moment Data

ALPHA	$C_{\ell\beta}$	$C_{\ell p}$	C_{ℓ_r}	$C_{\ell\delta_s}$	$C_{\ell\delta_{DH}}$	$C_{\ell\delta_{RU}}$	$C_{\ell\delta_{RL}}$	$C_{\ell\eta_y}$	$C_{\ell\dot{\eta}_y}$
-10	0.0014	-0.074	-0.15	0.00029	0.00010	0.00015	0.00004	0.0678	0.0243
-5	0.0004	-0.074	0	0.00041	0.00030	0.00006	0.00002	0.0678	0.0243
0	-0.0010	-0.077	0.15	0.00041	0.00028	0.00014	0.00003	0.0678	0.0243
5	-0.0023	-0.070	0.30	0.00041	0.00032	0.00024	0.00005	0.0678	0.0243
7.5	-0.0033	-0.047	0.38	0.00033	0.00032	0.00024	0.00006	0.0678	0.0243
10	-0.0043	-0.047	0.43	0.00022	0.00030	0.00026	0.00006	0.0678	0.0243
12.5	-0.0049	-0.020	0.48	0.00016	0.00028	0.00021	0.00005	0.0678	0.0243
15	-0.0049	0	0.50	0.00011	0.00023	0.00010	0.00003	0.0678	0.0243
17.5	-0.0049	0	0.45	0.00005	0.00022	0.00010	0.00002	0.0678	0.0243
20	-0.0049	0	0.38	0	0.00022	0.00009	0.00002	0.0678	0.0243

ALPHA	C_m	C_{m_q}	$C_{m_{\dot{\alpha}}}$	$C_{m\delta_s}$	$C_{m\delta_t}$	$C_{m\eta_z}$	$C_{m\dot{\eta}_z}$	$C_{m\delta_{cv}}$
-10	0.029	-35.0	-4.0	0.0080	-0.042	-0.0321	-0.159	0.014
-5	-0.111	-35.0	-4.0	0.0080	-0.042	-0.0321	-0.159	
0	-0.252	-34.7	-4.2	0.0090	-0.045	-0.0321	-0.159	
5	-0.399	-35.2	-5.2	0.0090	-0.046	-0.0321	-0.159	
7.5	-0.358	-34.0	-5.6	0.0090	-0.046	-0.0321	-0.159	
10	-0.300	-28.8	-6.0	0.0080	-0.045	0	0	
12.5	-0.260	-20.0	-6.6	0.0070	-0.043	0	0	
15	-0.265	-11.5	-4.5	0	-0.039	0	0	
17.5	0	-13.0	-2.6	0	-0.034	0	0	
20	0	-13.2	-0.8	0	-0.028	0	0	

Table A.2 - Aerodynamic Moment Data concluded

ALPHA	C_{n_β}	$C_{n_{\dot\beta}}$	C_{n_p}	C_{n_r}	$C_{n\delta_s}$	$C_{n\delta_{DH}}$	$C_{n\delta_{RU}}$	$C_{n\delta_{RL}}$
-10	0.0020	0.051	0.038	-0.140	0.00015	0.00016	-0.00031	-0.00044
-5	0.0019	0.065	-0.027	-0.135	0.00016	0.00013	-0.00031	-0.00044
0	0.0020	0.075	-0.080	-0.135	0.00018	0.00012	-0.00030	-0.00044
5	0.0023	0.070	-0.085	-0.130	0.00018	0.00012	-0.00030	-0.00044
7.5	0.0022	0.060	-0.065	-0.130	0.00021	0.00007	-0.00034	-0.00045
12.5	0.0019	0.133	0.055	-0.080	0.00021	0.00003	-0.00032	-0.00051
15	0.0017	0.228	0.030	-0.030	0.00014	0.00008	-0.00026	-0.00052
17.5	0.0012	0.288	0.025	-0.025	0.00006	0.00009	-0.00026	-0.00046
20	0.0005	0.309	0.015	-0.030	0	0.00003	-0.00026	-0.00038

ALPHA	$C_{n\eta_y}$	$C_{n\dot\eta_y}$						
-10	0.0080	0.0052						
-5	0.0080	0.0052						
0	0.0080	0.0052						
5	0.0080	0.0052						
7.5	0.0080	0.0052						
10	0.0080	0.0052						
12.5	0.0080	0.0052						
15	0.0080	0.0052						
17.5	0.0080	0.0052						
20	0.0080	0.0052						

Table A.3 - Aerodynamic Structural Data

ALPHA	C_{η_y}	$C_{\eta_y \beta}$	$C_{\eta_y p}$	$C_{\eta_y r}$	$C_{\eta_y \delta_a}$	$C_{\eta_y \delta_{DH}}$	$C_{\eta_y \delta_{RU}}$
-10	0	-0.00046	0.00157	0.00077	-0.0219	-0.0064	0.00367
-5							
0							
5							
7.5							
10							
12.5							
15							
17.5							
20							

ALPHA	$C_{\eta_y \delta_{RL}}$	$C_{\eta_y \eta_y}$	$C_{\eta_y \dot{\eta}_y}$	$C_{\eta_y \delta_{cv}}$			
-10	0.0011	-1.700	-0.923	0			
-5							
0							
5							
7.5							
10							
12.5							
15							
17.5							
20							

Table A.3 - Aerodynamic Structural Data concluded

ALPHA	C_{η_z}	$C_{\eta_z \alpha}$	$C_{\eta_z \dot{\alpha}}$	$C_{\eta_z q}$	$C_{\eta_z \delta_s}$	$C_{\eta_z \delta_t}$	$C_{\eta_z \eta_z}$
-10	0	-0.00113	0	-1.452	0.0009	-0.00342	0.00064
-5							
0							
5							
7.5							
10							
12.5							
15							
17.5							
20							
ALPHA	$C_{\eta_z \dot{\eta}_z}$	$C_{\eta_z \delta_{cv}}$					
-10	-0.00966	-0.00227					
-5							
0							
5							
7.5							
10							
12.5							
15							
17.5							
20							

Appendix 2
Structural Mode Data

The control point locations and corresponding normalized structural deflections for the study vehicle are presented in this appendix. Figure A.1 depicts the locations of the control points. Figure A.2 presents the sign conventions for the mode shapes and their deflections and slopes. The modal deflections are defined to be positive in the positive coordinate directions. They are normalized so that the deflection at the nose (i.e. fuselage station 0) is one foot. The structural coordinates are defined so that the x-axis lies along the longitudinal axis of the vehicle and is directed forward. The y-axis lies in the plane of the wings, is orthogonal to the x-axis and points out the right wing. The z-axis is orthogonal to the xy-plane and is directed downward. The origin of the xyz-coordinate system is at the center of mass of the aircraft.

The deflections of the control points for the lowest frequency symmetric and antisymmetric modes are presented in the tables that follow. This mode shape data was used to obtain the mode shape plots presented in Figure 3 in Chapter 2.

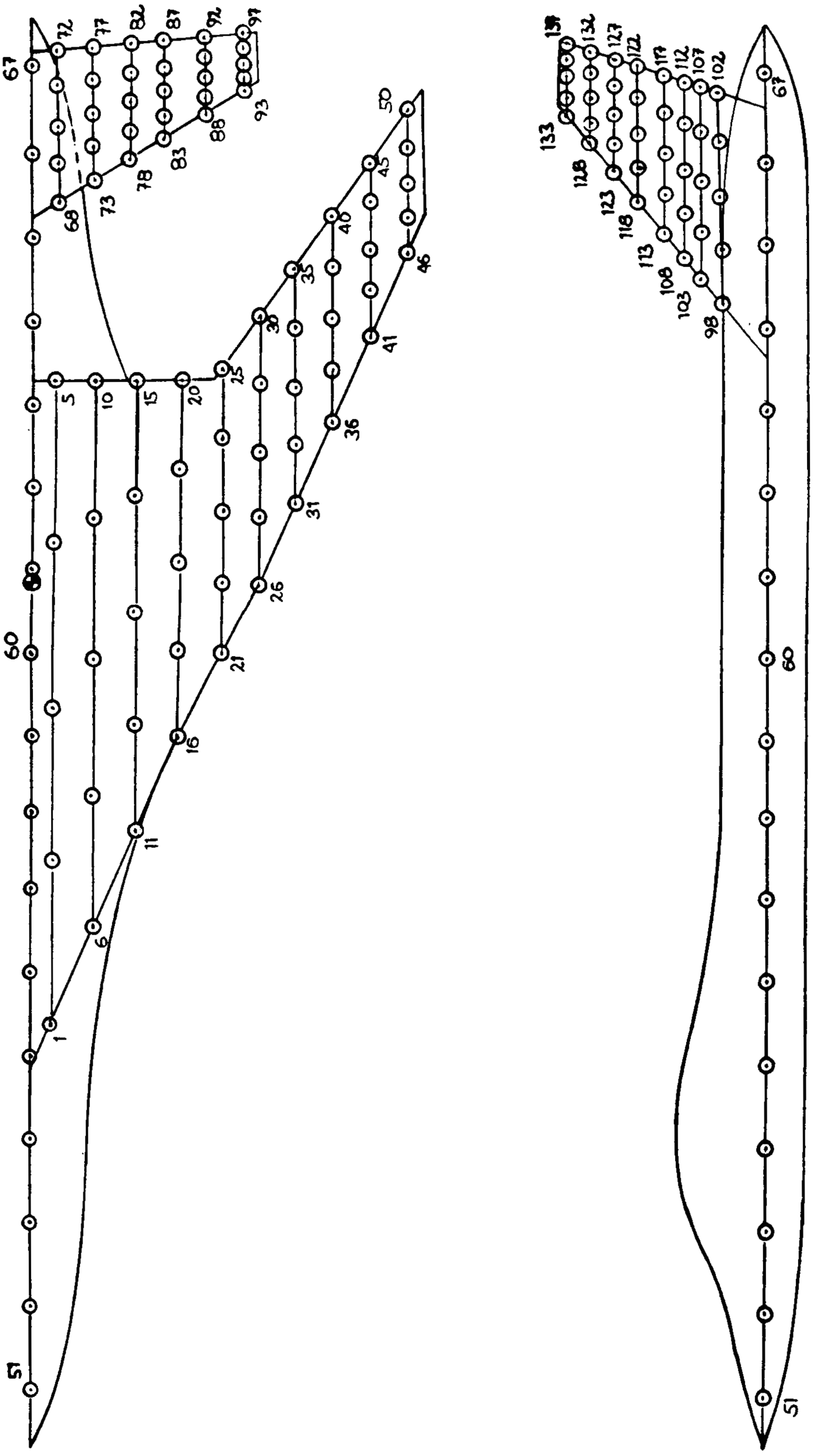
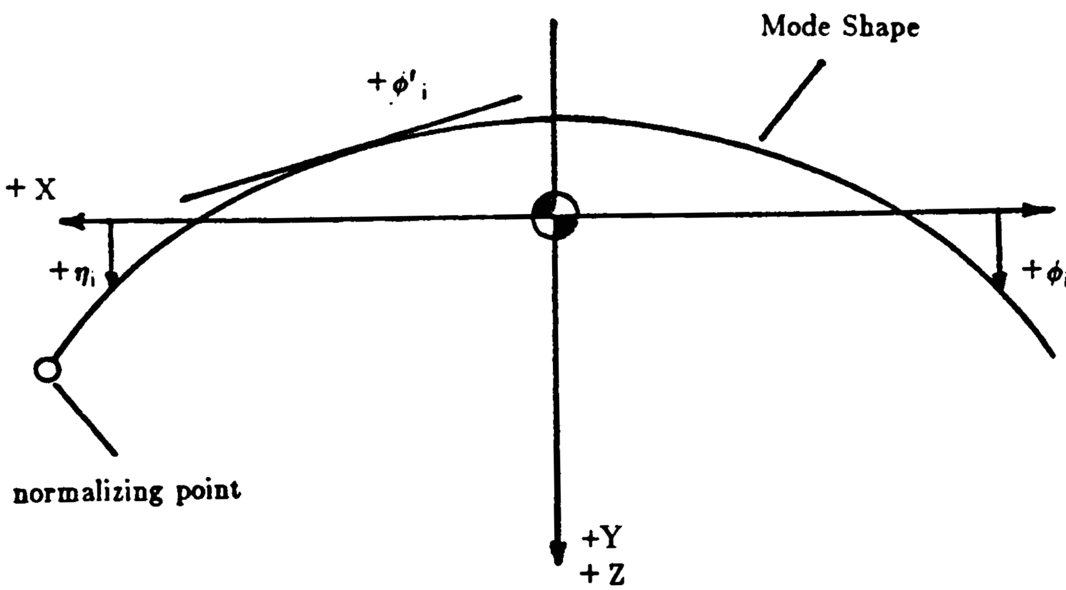


Figure A.1 - Structural Control Point Locations

MODE SHAPE SIGN CONVENTIONS



$\phi_i \triangleq$ mode deflection (feet)

$\phi'_i \triangleq$ mode slope (feet/feet)

$\eta_i \triangleq$ generalized deflection (dimensionless)

Figure A.2 - Mode Shape Sign Conventions

Table A.4 - Modal Data : Wing

Control Point	Fuselage Station (in.)	Butt Plane (in.)	Wing Deflections (ft.) Symmetric Mode	Wing Deflections (ft.) Antisymmetric Mode
1	509.0	24.0	0.134767	-0.00529188
2	708.25	24.0	-0.138436	-0.00511932
3	907.25	24.0	-0.141176	-0.00496657
4	1106.8	24.0	-0.0709361	0.175614
5	1306.0	24.0	0.0143585	0.470995
6	625.0	72.0	-0.0953299	-0.0155787
7	795.25	72.0	-0.154605	-0.0151372
8	965.5	72.0	-0.124002	-0.00717671
9	1135.8	72.0	-0.0587528	0.718319
10	1306.0	72.0	0.0143585	1.41295
11	740.0	120.0	-0.188116	0.711527
12	881.5	120.0	-0.157258	0.216667
13	1023.0	120.0	-0.101854	-0.216821
14	1164.5	120.0	-0.0359900	-0.00717671
15	1306.0	120.0	0.0400484	-1.61333
16	858.0	171.0	-0.182679	0.412947
17	970.0	171.0	-0.125595	-0.227527
18	1082.0	171.0	-0.0686746	-0.952831
19	1194.0	171.0	-0.0058470	-2.02406
20	1306.0	171.0	0.0712297	-3.58068
21	963.0	225.0	-0.130195	-0.352080
22	1052.5	225.0	-0.0807926	-0.949884
23	1142.0	225.0	-0.0289801	-1.79710
24	1231.5	225.0	0.0330662	-2.97565
25	1321.0	225.0	0.107921	-4.55961
26	1053.0	269.0	-0.0837392	-1.07092
27	1135.2	269.0	-0.0341160	-1.88686
28	1217.5	269.0	0.0233756	-2.96850
29	1299.8	269.0	0.0927204	-4.42628
30	1382.0	269.0	0.175921	-6.30396
31	1147.0	313.0	-0.0248385	-2.22464
32	1220.8	313.0	0.0298222	-3.28454
33	1294.5	313.0	0.0928292	-4.62097
34	1368.2	313.0	0.168843	-6.34319
35	1442.0	313.0	0.256431	-8.40589
36	1242.0	358.0	0.0501250	-3.89604
37	1307.4	358.0	0.109710	-5.19295
38	1372.8	358.0	0.178917	-6.77517
39	1438.1	358.0	0.257035	-8.62406
40	1503.5	358.0	0.339823	-1.06203
41	1339.0	403.0	0.145596	-6.19584
42	1395.8	403.0	0.211324	-7.73575
43	1452.5	403.0	0.280700	-9.39314
44	1509.2	403.0	0.354708	-11.1836
45	1566.0	403.0	0.433277	-13.0908
46	1434.0	447.0	0.264467	-9.20502
47	1482.5	447.0	0.327487	-10.7275
48	1531.5	447.0	0.392753	-12.3092
49	1580.2	447.0	0.459351	-13.9266
50	1629.0	447.0	0.525813	-15.5401

Table A.5 - Modal Data : Fuselage, Tail

Control Point	Fuselage Station (in.)	Butt Plane (in.)	Fuselage Displacement (ft.) Symmetric Mode	Antisymmetric Mode
51	72.0	0.0	1.00	1.00
52	172.0	0.0	0.725128	0.752280
53	272.0	0.0	0.444520	0.500628
54	372.0	0.0	0.220083	0.291652
55	472.0	0.0	0.0557356	0.131140
56	572.0	0.0	-0.0556486	0.0287140
57	672.0	0.0	-0.123779	-0.0395304
58	772.0	0.0	-0.152392	-0.0799198
59	872.0	0.0	-0.149516	-0.106551
60	972.0	0.0	-0.121980	-0.123343
61	1072.0	0.0	-0.0850331	-0.136570
62	1172.0	0.0	-0.0435321	-0.146232
63	1272.0	0.0	0.0124225	-0.150222
64	1372.0	0.0	0.0476976	-0.146850
65	1472.0	0.0	0.102925	-0.133034
66	1572.0	0.0	0.182146	-0.109942
67	1683.0	0.0	0.283587	-0.0858145

Control Point	Fuselage Station (in.)	Butt Plane (in.)	Horizontal Tail Displacement (ft.) Symmetric Mode	Antisymmetric Mode
68	1509.0	2.6	0.139051	0.579749
69	1557.75	2.6	0.167729	0.580116
70	1606.5	2.6	0.196390	0.580502
71	1655.25	2.6	0.225057	0.508069
72	1704.0	2.6	0.253724	0.581237
73	1538.0	7.0	0.155290	1.53797
74	1580.75	7.0	0.183866	1.59169
75	1623.5	7.0	0.212379	1.65005
76	1666.25	7.0	0.241100	1.71845
77	1709.0	7.0	0.269892	1.78918
78	1564.0	11.2	0.175834	2.62599
79	1601.25	11.2	0.200924	2.64232
80	1638.5	11.2	0.226280	2.68232
81	1675.75	11.2	0.251626	2.74309
82	1713.0	11.2	0.276976	2.80618
83	1592.0	15.6	0.198652	3.64985
84	1623.0	15.6	0.220458	3.69440
85	1654.0	15.6	0.242372	3.74502
86	1685.0	15.6	0.264412	3.81121
87	1716.0	15.6	0.286702	3.87768
88	1621.0	20.1	0.225144	4.81932
89	1646.0	20.1	0.243351	4.86860
90	1671.0	20.1	0.261732	4.92077
91	1696.0	20.1	0.280271	4.97623
92	1721.0	20.1	0.298967	5.03478
93	1649.0	24.6	0.253577	6.02821
94	1668.0	24.6	0.267826	6.08184
95	1687.0	24.6	0.282179	6.13875
96	1706.0	24.6	0.296624	6.19836
97	1725.0	24.6	0.311216	6.26058

Table A.5 - Modal Data : Fuselage, Tail concluded

Control Point	Fuselage Station (in.)	Butt Plane (in.)	Vertical Tail Displacement (ft.) Antisymmetric Mode Only
98	1406.4	84.54	0.960609
99	1470.02	84.54	1.02464
100	1533.65	84.54	1.08966
101	1597.27	84.54	1.13121
102	1660.9	84.54	1.17671
103	1433.9	107.5	1.50415
104	1492.65	107.5	1.57845
105	1551.4	107.5	1.60744
106	1610.15	107.5	1.65526
107	1668.9	107.5	1.72058
108	1458.4	127.23	1.96203
109	1512.65	127.23	1.99865
110	1566.9	127.23	2.05256
111	1621.15	127.23	2.10676
112	1675.4	127.23	2.16116
113	1488.9	152.0	2.48309
114	1537.4	152.0	2.55807
115	1585.9	152.0	2.63681
116	1634.4	152.0	2.73140
117	1682.9	152.0	2.82589
118	1527.9	184.62	3.17362
119	1569.4	184.62	3.32290
120	1610.9	184.62	3.43652
121	1652.4	184.62	3.53246
122	1693.9	184.62	3.68473
123	1563.4	213.31	4.00473
124	1598.4	213.31	4.07662
125	1633.4	213.31	4.16280
126	1668.4	213.31	4.29739
127	1703.4	213.31	4.44783
128	1598.4	242.18	4.74522
129	1627.15	242.18	4.85121
130	1655.9	242.18	4.95758
131	1684.65	242.18	5.07749
132	1713.4	242.18	5.26976
133	1635.4	269.15	5.51623
134	1658.02	269.15	5.61797
135	1680.65	269.15	5.74599
136	1703.27	269.15	5.89924
137	1725.9	269.15	6.04927

Appendix 3
SCAS Gain Schedules and Nonlinear Effects

The gain schedules that were used in the stability and control augmentation systems for the study vehicle are presented in this appendix. Nonlinear properties and gearing effects in the control system are also presented here. Figures A.3 and A.4 depict the variation of the pitch SCAS gains $K_{M\theta}$ and $K_{h\theta}$ with variations in flight condition (i.e. Mach number and altitude, respectively). Figure A.5 depicts the variation of the yaw SCAS gain $K_{h\psi}$ with variations in altitude. Figure A.6 presents the nonlinear relationship between longitudinal stick displacement and symmetric horizontal tail deflections. Figure A.7 presents the relationship between lateral stick displacement and spoiler deflections. Finally, Figure A.8 depicts the limits that are imposed on differential tail displacement due to commanded symmetric tail displacement.

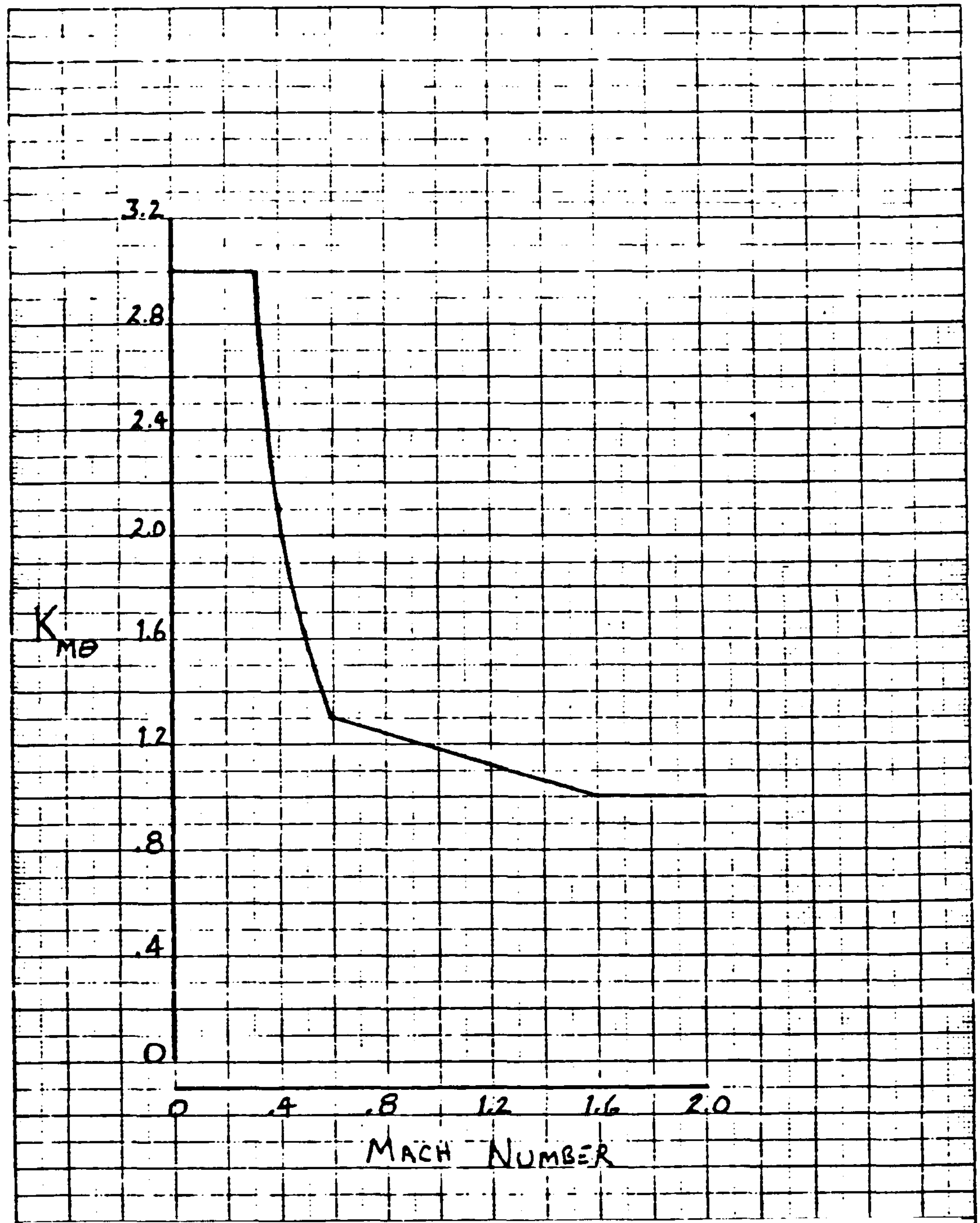


Figure A.3 - Pitch Axis Gain Schedule : $K_{M\theta}$

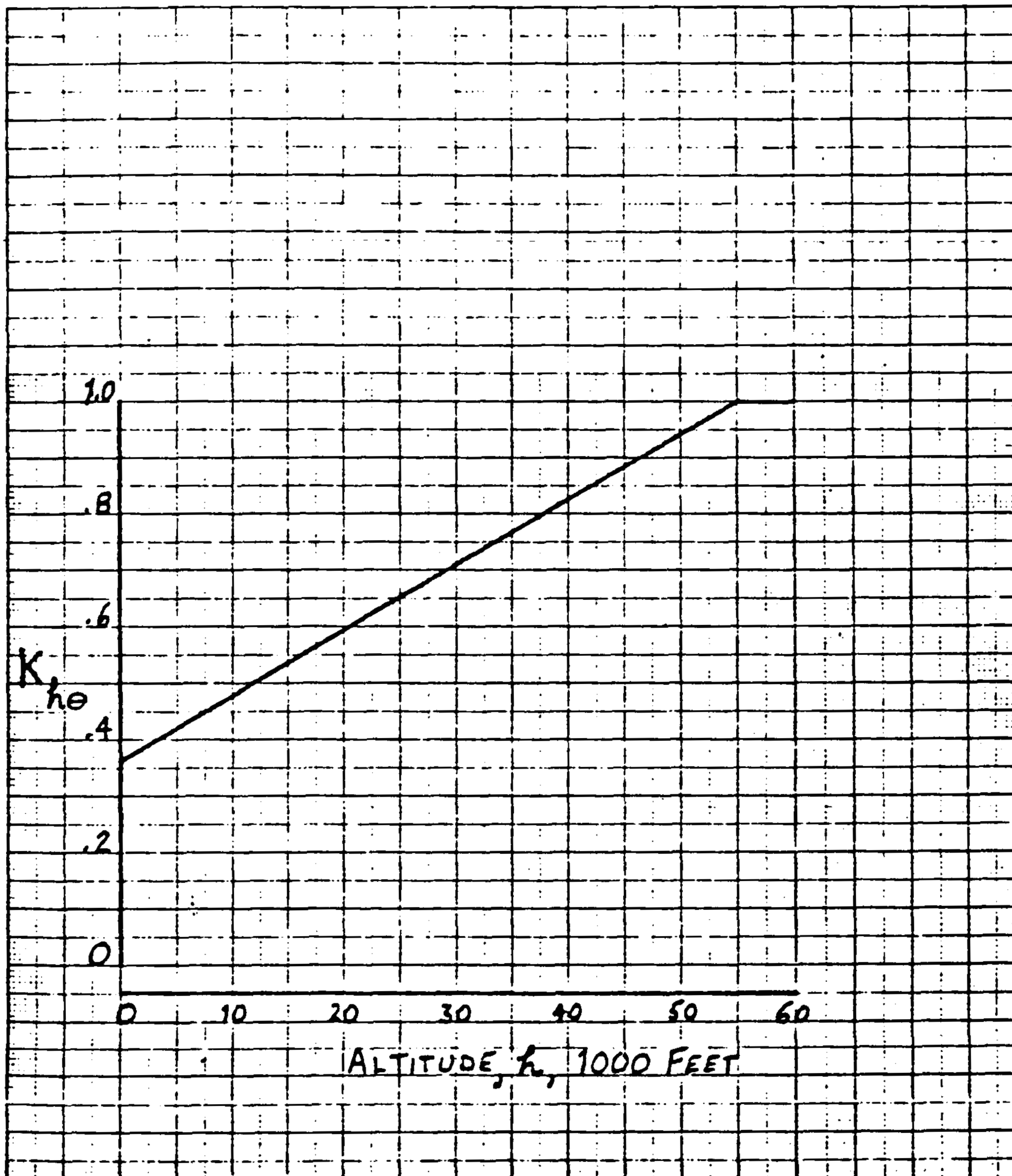


Figure A.4 - Pitch Axis Gain Schedule : $K_{h\theta}$

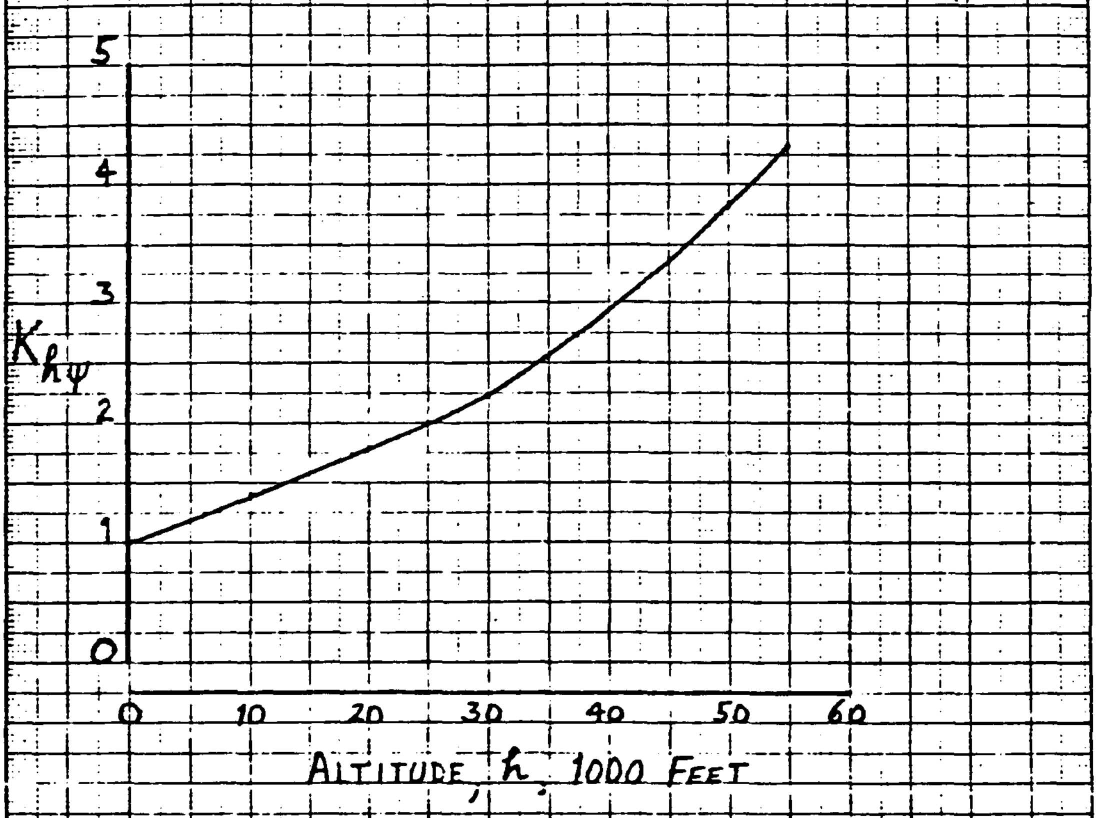


Figure A.5 - Yaw Axis Gain Schedule : $K_{h\psi}$

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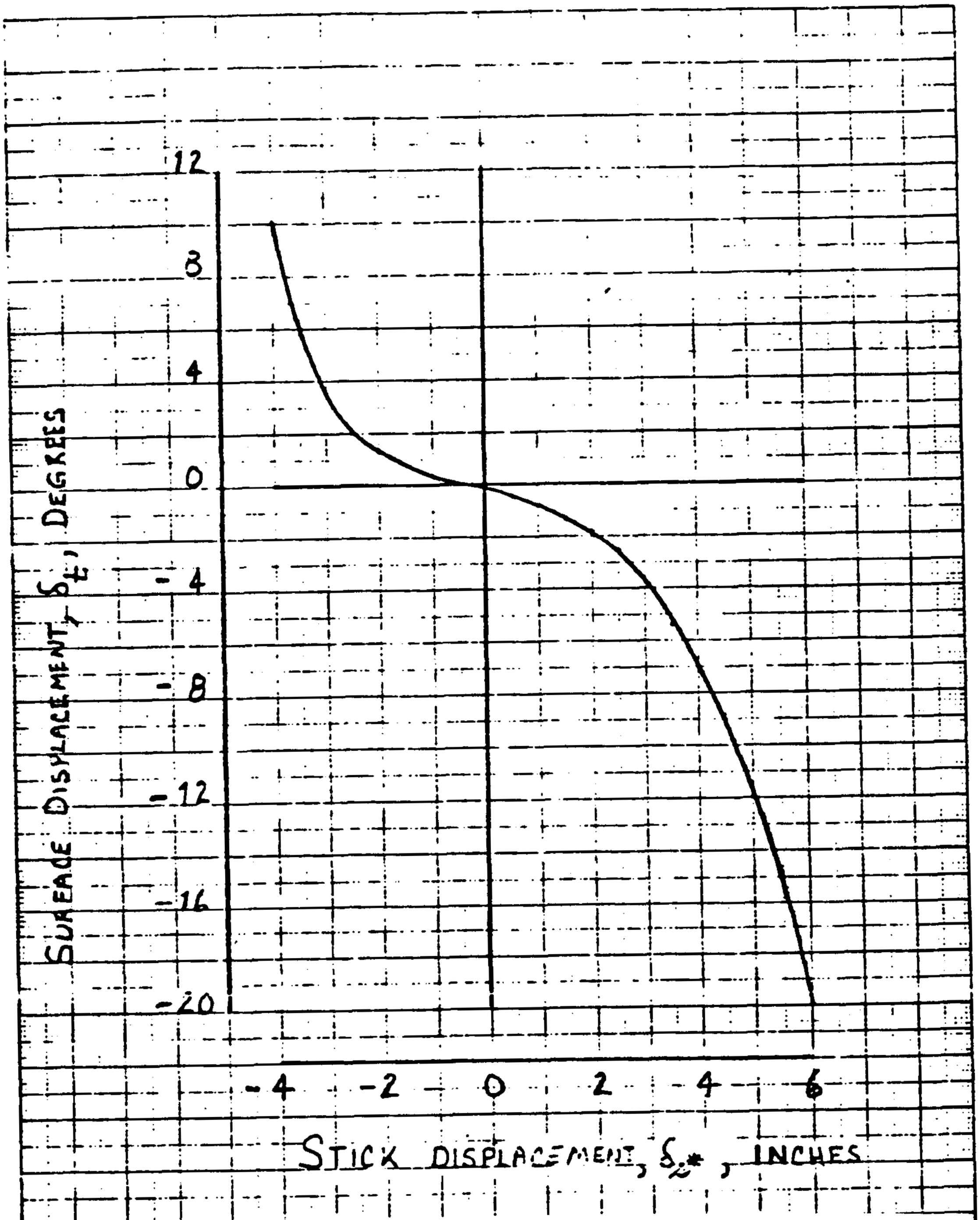

Figure A.6 - Pitch Axis Gearing Effects :
Tail Surface Deflection vs.Stick Displacement

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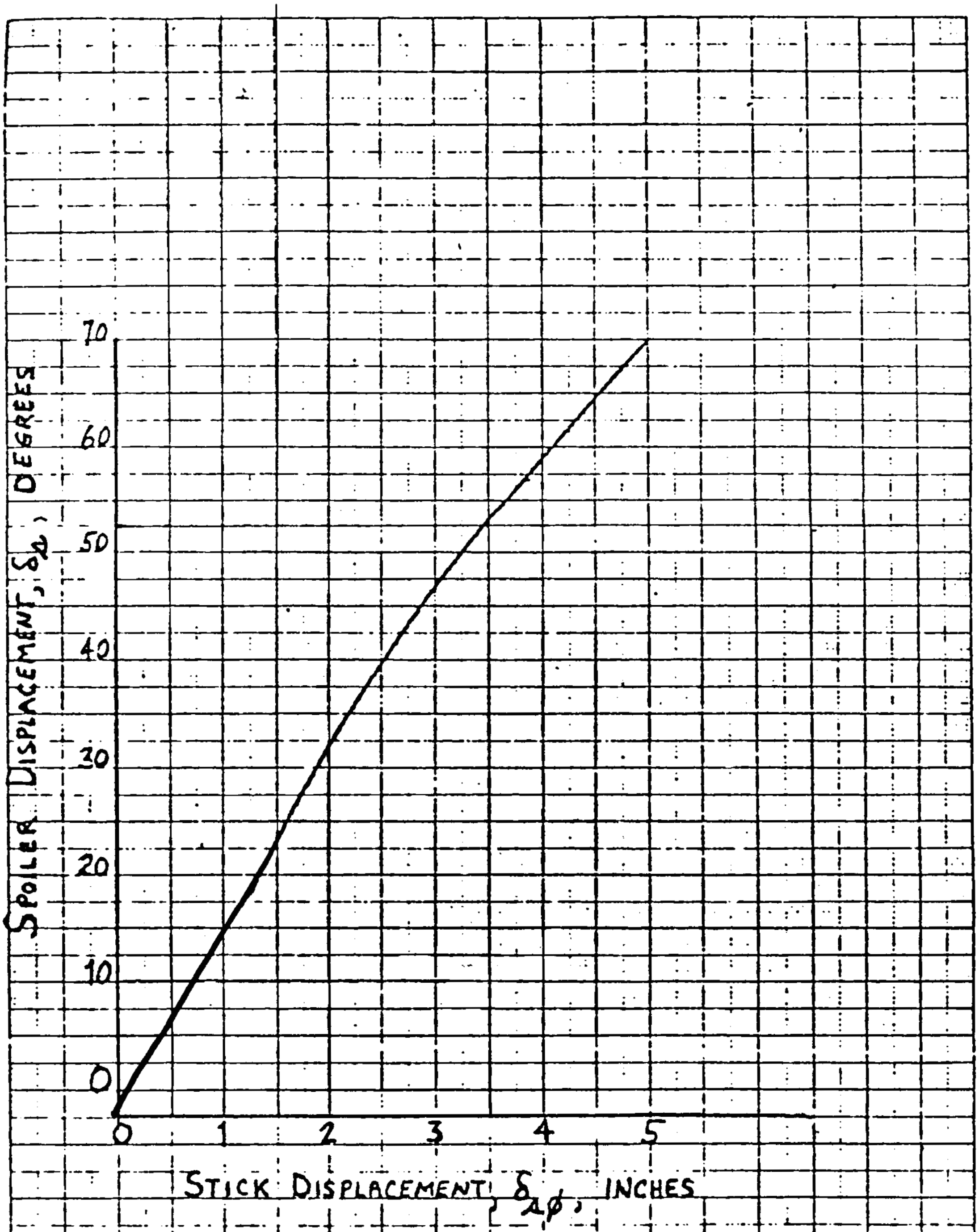

Figure A.7 - Pitch Axis Gearing Effects :

Spoiler Surface Deflection vs. Stick Displacement

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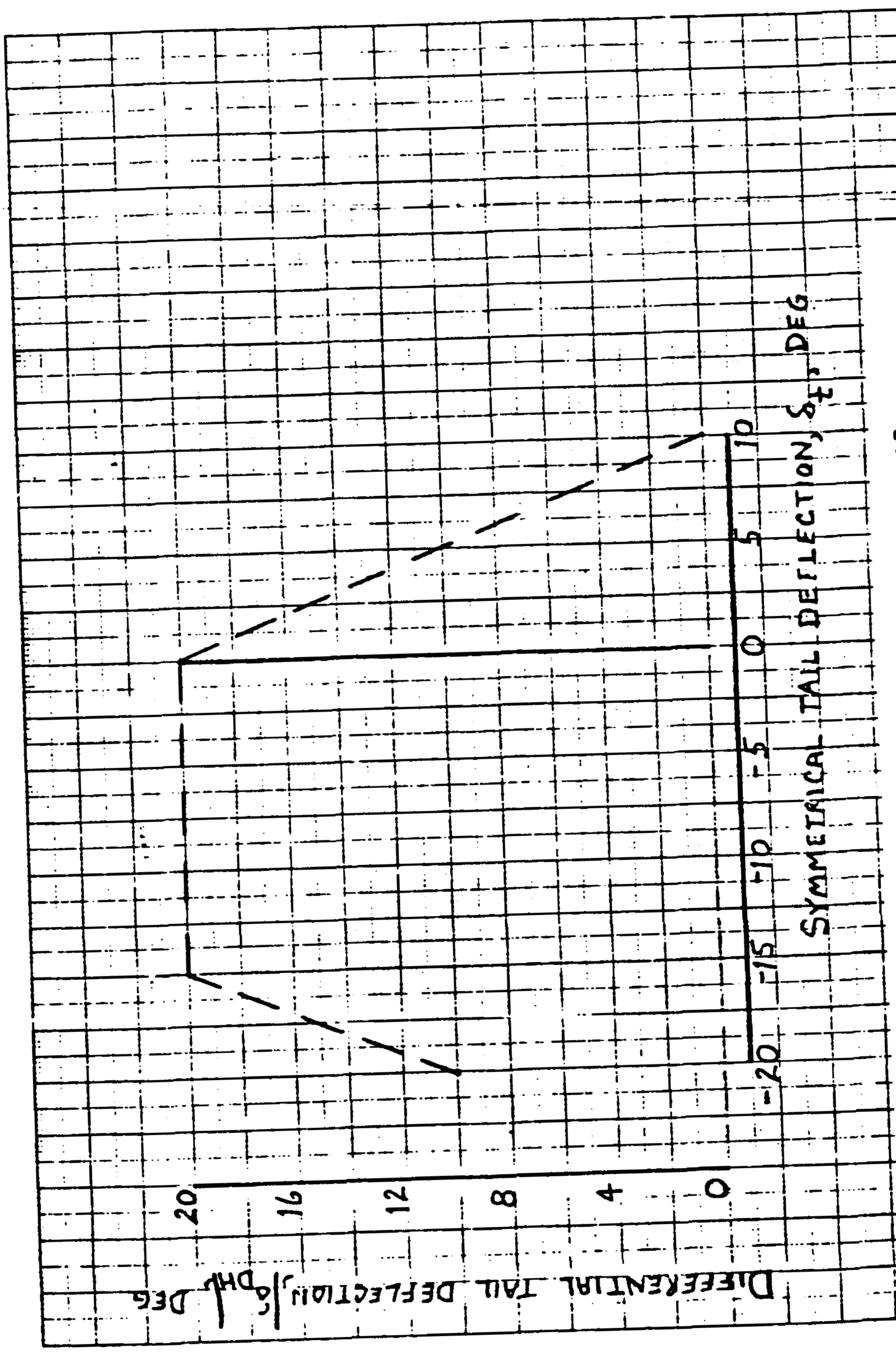

Figure A.8 - Limits imposed on δ_{DH} as a function of δ_t

Appendix 4
Configuration Listings

This appendix contains the specifications for the vehicle configurations that were studied in the simulation experiment. It also contains a chronological listing of the runs that were completed. The first table below presents the values for the dynamic parameters that were assigned to each configuration. These dynamic parameters specify the degree of flexibility in terms of the structural mode vibration frequencies ,ω_y and ω_z, which correspond to the antisymmetric and symmetric modes, respectively. The parameters ''ETAY'' and ''ETAZ'' indicate whether or not the antisymmetric or symmetric modes, respectively, were implemented in the simulation. The dynamic parameters also indicate the control system status. The SCAS status is indicated by the parameter SCAS which takes on values of either ON or OFF, if ON the stability and control augmentation systems were enabled. The gain on pitch rate in the pitch SCAS, KQ, is also indicated since this parameter was varied throughout the experiment. The status of the phugoid augmentation controller (i.e. the ''speed hold'') is indicated by the SPDH parameter. When this value is ON the phugoid augmentation was enabled and when OFF the phugoid augmentation was not used. An additional parameter, OLD CASE, is included in the configuration list. This parameter indicates the case number assigned to the combination of experimental and dynamic parameters when the experiment was conducted. The old case number is useful when cross referencing the experimental data.

The chronological listing provides the case number associated with each simulation run that was made during the experiment. This chronological listing provides a means by which any run number or configuration number can be cross referenced. It also gives some indication of the availability of various forms of data that was collected during the simulation study such as digitally tabulated response data or strip chart plots of vehicle responses.

Table A.6 - Configuration Specifications

CASE NO.	ETAY	ETAZ	OMEGY	OMEGZ	SCAS	KQ	SPDH	OLD CASE
1A-11-1	OFF	OFF	-	-	ON	2.0	OFF	4
1A-11-2	OFF	ON	2.0	2.0	ON	2.0	OFF	10
1A-11-3	OFF	ON	2.0	1.75	ON	2.0	OFF	16
1A-11-4	OFF	ON	2.0	1.5	ON	2.0	ON	22
1A-21-1	OFF	OFF	-	-	ON	1.6	OFF	1*
1A-21-2	OFF	OFF	-	-	ON	2.0	OFF	1
1A-21-3	OFF	ON	2.0	2.0	ON	2.0	OFF	7
1A-21-4	OFF	ON	2.0	1.5	ON	2.0	ON	21
1B-11-1	OFF	OFF	-	-	ON	2.0	OFF	5
1B-11-2	ON	OFF	2.0	2.0	ON	2.0	OFF	11
1B-11-3	ON	OFF	1.5	2.0	ON	2.0	ON	32
1B-21-1	OFF	OFF	-	-	ON	1.6	OFF	2*
1B-21-2	OFF	OFF	-	-	ON	2.0	OFF	2
1B-21-3	ON	OFF	2.0	2.0	ON	2.0	OFF	8
1B-21-4	ON	OFF	1.5	2.0	ON	2.0	ON	31
1C-11-1	OFF	OFF	-	-	ON	2.0	OFF	6
1C-11-2	ON	ON	2.0	2.0	ON	2.0	OFF	12
1C-11-3	ON	ON	2.0	2.0	ON	2.0	ON	13
1C-11-4	ON	ON	2.0	1.75	ON	2.0	ON	18
1C-11-5	ON	ON	2.0	1.5	ON	2.0	ON	24
1C-11-6	ON	ON	1.5	2.0	ON	2.0	ON	34
1C-11-7	ON	ON	1.0	2.0	ON	2.0	ON	40
1C-11-8	ON	ON	2.0	1.0	ON	2.0	ON	49
1C-12-1	ON	ON	2.0	2.0	ON	2.0	ON	14,50
1C-12-2	ON	ON	2.0	1.75	ON	2.0	ON	19
1C-12-3	ON	ON	2.0	1.5	ON	2.0	ON	25,48,51
1C-12-4	ON	ON	2.0	1.25	ON	2.0	ON	27
1C-12-5	ON	ON	2.0	1.0	ON	2.0	ON	29,47,52
1C-12-6	ON	ON	1.5	2.0	ON	2.0	ON	35
1C-12-7	ON	ON	1.0	2.0	ON	2.0	ON	41
1C-12-8	ON	ON	2.0	0.8	ON	2.0	ON	45,53
1C-12-9	ON	ON	2.0	0.9	ON	2.0	ON	46
1C-12-10	ON	ON	2.0	2.0	ON	1.6	ON	54
1C-12-11	ON	ON	2.0	1.5	ON	1.6	ON	55
1C-12-12	ON	ON	2.0	1.0	ON	1.6	ON	56
1C-12-13	ON	ON	2.0	0.8	ON	1.6	ON	57
1C-12-14	ON	ON	2.0	2.0	OFF	-	ON	58
1C-12-15	ON	ON	2.0	1.5	OFF	-	ON	59
1C-12-16	ON	ON	2.0	1.0	OFF	-	ON	60
1C-12-17	OFF	OFF	-	-	ON	2.0	ON	29*

Table A.6 - Configuration Specifications concluded

1C-21-1	OFF	OFF	-	-	ON	1.6	OFF	3*
1C-21-2	OFF	OFF	-	-	ON	2.0	OFF	3
1C-21-3	ON	ON	2.0	2.0	ON	2.0	OFF	9,111
1C-21-4	ON	ON	2.0	1.75	ON	2.0	ON	17
1C-21-5	ON	ON	2.0	1.5	ON	2.0	ON	23
1C-21-6	ON	ON	1.5	2.0	ON	2.0	ON	33
1C-21-7	ON	ON	1.0	2.0	ON	2.0	ON	39
1C-21-8	ON	ON	2.0	2.0	ON	ESC	OFF	113
1C-22-1	ON	ON	2.0	2.0	ON	2.0	ON	20
1C-22-2	ON	ON	2.0	1.5	ON	2.0	ON	26
1C-22-3	ON	ON	2.0	1.25	ON	2.0	ON	28
1C-22-4	ON	ON	2.0	1.0	ON	2.0	ON	30
1C-22-5	ON	ON	1.5	2.0	ON	2.0	ON	36
1C-22-6	ON	ON	1.0	2.0	ON	2.0	ON	42
1C-22-7	ON	ON	2.0	1.0	ON	1.6	ON	56B
1C-22-8	ON	ON	2.0	0.8	ON	2.0	ON	45B
1C-22-9	ON	ON	2.0	1.5	ON	ESC	OFF	75
1C-22-10	ON	ON	2.0	1.5	ON	2.0	OFF	76
1C-22-11	ON	ON	2.0	2.0	ON	2.0	OFF	77,110
1C-22-12	ON	ON	2.0	2.0	ON	ESC	OFF	112
2C-11-1	OFF	OFF	-	-	ON	1.6	ON	61
2C-11-2	ON	ON	2.0	2.0	ON	1.6	ON	62
2C-11-3	ON	ON	2.0	2.0	ON	1.6	ON	63
2C-11-4	ON	ON	2.0	2.0	ON	1.6	ON	64
2C-11-5	ON	ON	2.0	2.0	ON	2.0	ON	78
2C-11-6	ON	ON	2.0	1.5	ON	2.0	ON	79,85
2C-11-7	ON	ON	2.0	1.0	ON	2.0	ON	80
2C-11-8	ON	ON	2.0	1.5	ON	2.0	OFF	91
2C-11-9	ON	ON	2.0	1.5	ON	2.0	OFF	92
2C-11-10	ON	ON	2.0	1.0	ON	2.0	OFF	93
2C-11-11	ON	ON	2.0	1.0	ON	2.0	ON	93B
2C-11-12	ON	ON	2.0	0.8	ON	2.0	OFF	94
2C-11-13	ON	ON	2.0	0.8	ON	2.0	ON	94B
2C-12-1	ON	ON	2.0	2.0	ON	2.0	ON	82
2C-12-2	ON	ON	2.0	1.0	ON	2.0	ON	83
2C-12-3	ON	ON	2.0	1.5	ON	2.0	ON	84
2C-12-4	OFF	OFF	-	-	ON	2.0	OFF	90
2C-12-5	OFF	OFF	-	-	ON	2.0	ON	90B
2C-12-6	ON	ON	2.0	2.0	OFF	-	OFF	114
2C-21-1	ON	ON	2.0	1.0	ON	2.0	ON	81,101
2C-21-2	ON	ON	2.0	2.0	ON	2.0	ON	99
2C-21-3	ON	ON	2.0	1.5	ON	2.0	ON	100
2C-21-4	ON	ON	2.0	1.0	ON	2.0	OFF	93C

Table A.7 - List of Simulation Runs

DATE	RUN	CASE	COMMENT
4/30	1	1A-21-1	no taped data, limited strips
	2	1B-21-1	"
	3	1C-21-1	"
	4	1A-21-2	"
	5	1A-21-2	"
5/2	1	1A-21-1	
	2	1B-21-2	
	3	1C-21-2	
	4	1A-11-1	
	5	1B-11-1	
	6	1C-11-1	
5/3	1	1C-11-1	tau(3) = 0
	2	1C-11-1	
	3	1A-21-3	
	4	1B-21-3	
	5	1C-21-3	
	6	1A-11-2	
	7	1B-11-2	
	8	1C-11-2	
	9	1C-11-3	
	10	1C-12-1	
	11	1A-21-4	
5/7	1	1C-11-1	
	2	1A-11-2	
	3	1C-11-2	
	4	1C-11-3	
	5	1A-21-3	
	6	1B-21-3	
	7	1C-21-3	
	8	1C-11-3	
	9	1C-12-1	
5/8	1	1C-11-1	
	2	1C-11-3	
	3	1C-12-1	
	4	1A-11-3	
	5	1A-11-3	
	6	1C-21-4	
	7	1C-21-4	
	8	1C-11-4	

Table A.7 - List of Simulation Runs continued

5/10	1	1C-21-2	not on tape
	2	1C-11-3	"
	3	1C-11-4	"
	4	1C-12-2	"
	5	1C-22-1	"
	6	1C-11-4	"
	7	1A-21-4	"
	8	1A-11-4	"
	9	1C-11-5	"
5/14	1	1A-21-4	
	2	1A-11-4	
	3	1C-21-5	
	4	1C-11-5	
	5	1C-12-3	
	6	1C-22-2	
5/16	1	?	tape only, no comment no strip
5/17	1	1C-12-4	
	2	1C-22-3	
	3	1C-12-5	
	4	1C-12-17	
	5	1C-22-3	
	6	1C-22-4	
	7	1B-21-4	
	8	1B-11-3	
	9	1C-21-6	
	10	1C-11-6	
	11	1C-12-6	
	12	1C-22-5	
5/21	1	1C-12-8	
	2	1C-12-9	
	3	1C-12-8	
	4	1C-12-5	
	5	?	on tape only
	6	1C-12-3	
	7	1C-12-1	
	8	1C-11-3	
	9	1C-11-5	
	10	1C-11-8	
5/22	1-4	1C-12-1	no strips, some comments

Table A.7 - List of Simulation Runs concluded

6/3	1	1C-22-9	
	2	1C-22-10	
	3	1C-22-11	
	4	2C-11-5	
	5	2C-11-6	
	6	2C-11-7	
	7	2C-21-1	
6/4	1	1C-22-9	
	2	1C-22-10	
	3	1C-22-9	
	4	1C-22-11	
	5	2C-21-4	
	6	2C-11-7	
	7	2C-11-5	
	8	2C-12-1	
	9	2C-12-2	
	10	2C-12-3	
	11	2C-11-6	
6/6	1	2C-12-4	
	2	2C-11-8	
	3	2C-11-9	
	4	2C-11-10	
	5	2C-11-12	
	6	2C-11-11	
	7	2C-11-13	
	8	2C-21-2	
	9	2C-21-3	
	10	2C-21-1	
	11	2C-12-5	
6/11	1	1C-22-12	
	2	1C-22-11	
	3	1C-21-3	
	4	1C-21-8	
	5	1C-21-8	
	6	1C-22-12	
	7	1C-22-11	no tape, no strips
	8	1C-22-12	"
	9	1C-21-8	"
	10	2C-12-6	"

Table A.7 - List of Simulation Runs continued

5/24	1	1C-12-1	
	2	1C-12-3	
	3	1C-12-5	
	4	1C-12-8	
	5	1C-12-10	
	6	1C-12-11	
	7	1C-12-12	
	8	1C-12-13	
	9	1C-12-10	
	10	1C-12-11	
	11	1C-12-12	
	12	1C-22-7	
	13	1C-12-13	
	14	1C-12-14	
	15	1C-12-15	
	16	1C-12-16	
5/29	1	1C-12-3	
	2	1C-12-5	
	3	1C-22-8	
	4	1C-12-8	
	5	1C-11-2	
	6	1C-11-6	
	7	1C-12-6	
	8	1C-21-7	
5/30	1	1C-11-3	not on tape
	2	1C-21-6	"
	3	1C-21-6	"
	4	1C-11-6	"
	5	1C-11-3	"
	6	1C-12-6	"
	7	1C-22-5	"
	8	1C-21-7	"
	9	1C-11-7	"
5/31	1	1C-11-1	
	2	1C-11-7	
	3	1C-12-7	
	4	1C-22-6	
	5	2C-11-1	
	6	2C-11-2	
	7	2C-11-3	
	8	2C-11-4	

Appendix 5
Experimental Summary Sheets

The complete set of summary sheets for the simulation experiment are presented in this appendix. The summary sheets provide basic information about each simulation run that was made. This basic information consists of the case number, run number, pilot identifier and dynamic parameters associated with each run. The summary sheets also provide statistical performance data which includes the mean errors, $\varepsilon_{long.}$ and $\varepsilon_{lat.}$, and standard deviations, $\sigma_{long.}$ and $\sigma_{lat.}$, of the tracking errors. The longitudinal axis values correspond to pitch errors for the pitch/roll tracking task and flight-path errors for the flight-path/heading task. The lateral axis values correspond to roll errors for the pitch/roll tracking task and heading angle errors for the flight-path/heading task.

Probably the most important items recorded on the summary sheets are the subjective pilot ratings and pilot/evaluator comments. The pilot ratings indicate the level of handling qualities associated with each run measured on the Cooper-Harper scale. The comments consist of pilot opinions and recommendations regarding the vehicle dynamics and evaluator comments that document significant observations made by the engineer/evaluator during the experiment.

Table A.8 - Data Summary Sheets

CASE NO. 1A-11-1	SPECS : η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 4	
RUN/PILOT 5-2-1 / B	SCORES : ε_{long} = .155 σ_{long} = 1.02 ε_{lat} = .373 σ_{lat} = .492	COOPER-HARPER RATING N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO. 1A-11-1	SPECS : η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 4	
RUN/PILOT 5-2-4 / B	SCORES : ε_{long} = .155 σ_{long} = 1.02 ε_{lat} = .373 σ_{lat} = .492	COOPER-HARPER RATING N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-2	η_y : OFF $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 10	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-6 / B	$\varepsilon_{long} = .048$ $\sigma_{long} = 1.40$ $\varepsilon_{lat} = -.056$ $\sigma_{lat} = .387$	N/A

COMMENTS :

- MOTION TASK HARDER AND MORE DIFFICULT

- WORSE THAN NO MOTION (THE SENSATION NOT NECESSARILY THE PERFORMANCE)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-2	η_y : OFF ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 10	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-2 / B	ε_{long} = .15 σ_{long} = 1.37 ε_{lat} = .10 σ_{lat} = .58	N/A

COMMENTS :

- DEFINITELY MORE COMPENSATION THAN PREVIOUS RUN

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-3	η_y : OFF ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 1.75 SPEED HOLD ; ON OLD CASE NO. : 16	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-4 / B	ε_{long} = .152 σ_{long} = 1.39 ε_{lat} = -.129 σ_{lat} = .71	N/A

COMMENTS :

- FLEW AGGRESSIVELY

- OBVIOUSLY MORE JUMPY THAN BEFORE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-3	η_y : OFF $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.75$ SPEED HOLD ; ON OLD CASE NO. : 16	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-5 / B	$\varepsilon_{long} = .175$ $\sigma_{long} = 1.87$ $\varepsilon_{lat} = -.35$ $\sigma_{lat} = .468$	N/A

COMMENTS :

- FELT THAT WAS THE BEST HE COULD DO WITHOUT EXCITING THE STRUCTURAL MODES
- ACCEPTING WIDER TOLERANCE AND EXCURSION
- LEARNED TO COMPENSATE FOR JUMP WITH SMOOTHER TECHNIQUE
- CAN KEEP FROM EXCITING THE MODES BUT WITH LOWER FTEQUENCIES PERFORMANCE IS DEGRADED, WHERE BEFORE IS WAS NOT DEGRADED MUCH AT ALL

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-4	η_y : OFF ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 22	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-8 / B	ε_{long} = .012 σ_{long} = 1.56 ε_{lat} = -.055 σ_{lat} = .365	N/A

COMMENTS :

- MUCH LARGER AMPLITUDE OF OSCILLATION
- ADEQUATE PERFORMANCE NOT ACHIEVABLE
- PITCH OVERSHOOT, PIO AND LAG
- HAVE TO HOLD STICK INTIL ■SPRING■ CATCHES UP
- HAD TO REDUCE GAINS OR THINGS GOT BAD

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-11-4	η_y : OFF ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 22	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-14-2 / B	ε_{long} = .167 σ_{long} = 1.7 ε_{lat} = .14 σ_{lat} = .415	7

COMMENTS :

- CAN IDENTIFY FLEX OSCILLATIONS EASIER WITH MOTION
- CUES HELP; WITHOUT MOTION IT IS HARD TO TELL WHETHER A VISUAL ■ATTITUDE■ CHANGE IN THE DISPLAY IS DUE TO ACTUAL ATTITUDE CHANGE OR FLEX
- TASK A LITTLE EASIER THAN CASE 1A-21-1; CAN KEEP MEAN ERROR AROUND ZERO AND LET OSCILLATIONS DIE OUT

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-1	η_y : OFF ω_y = - SCAS : ON K_q = 1.6 η_z : OFF ω_z = - SPEED HOLD : OFF OLD CASE NO. : 1*	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
4-30-1 / A	ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	N/A

COMMENTS :

- ZERO CROSSINGS BOBBLE

- SMALL PIO[redacted]S WITH NOMINAL TRACKING

- EARLY IN RUN, TARGET REVERSED

- HIGH GAIN

- SIGMA(P)**2 = 0.77

Table A.8 - Data Summary Sheets continued

CASE NO. 1A-21-2	SPECS : η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 1	
RUN/PILOT 4-30-4 / A	SCORES : ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	COOPER-HARPER RATING N/A

COMMENTS :

- WELL DAMPED, KQ=2.0 APPEARS TO BE AN IMPROVEMENT OVER 1.6

- SIGMA(P)**2 = 0.77

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-2	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_x : OFF ω_x = - SPEED HOLD ; OFF OLD CASE NO. : 1	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
4-30-5 / A	ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	N/A

COMMENTS :

- SIGMA(P)**2 = 0.77 ; KG = 5.0 (RATHER THAN NOMINAL 4.5)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-3	η_y : OFF $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 7	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-3 / B	$\varepsilon_{long} = .240$ $\sigma_{long} = 1.23$ $\varepsilon_{lat} = -.051$ $\sigma_{lat} = .345$	N/A

COMMENTS :

- PITCH MORE DIFFICULT

- MORE COMPENSATION REQUIRED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-3	η_y : OFF $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 7	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-5 / B	$\varepsilon_{long} = .035$ $\sigma_{long} = 1.65$ $\varepsilon_{lat} = .173$ $\sigma_{lat} = .458$	N/A

COMMENTS :

- MOTION GAVE PERFORMANCE CUES, IN THE SENSE THAT IT WAS AN AID

- CAN TELL THE DEFFIERENCE BETWEEN HIS PIO[redacted]S AND THE FLEX MODE AND HE KNOWS NOT TO FIGHT IT

- WITH NO MOTION, PERHAPS IT[redacted]S HARDER TO TELL THE DIFFERENCE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-4	η_y : OFF ω_y = 2.0 SCAS : ON K_a = 2.0 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 21	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-11 / B	ε_{long} = .513 σ_{long} = 2.02 ε_{lat} = -1.16 σ_{lat} = 1.32	N/A

COMMENTS :

- ALMOST IMPOSSIBLE WITH AND PRECISION
- DOESN'T THINK THERE IS A LAG PROBLEM, BUT DID PERCEIVE A LAG
- OBVIOUS VISUAL OVERSHOOTS

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1A-21-4	η_y : OFF $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 21	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-7 / B	$\varepsilon_{long} = .348$ $\sigma_{long} = 1.49$ $\varepsilon_{lat} = -.041$ $\sigma_{lat} = .574$	N/A

COMMENTS :

- TENDENCY TO PITCH OVERSHOOT AND PIO
- LOWER INTENSITY DUE TO NOT OVERCONTROLLING
- BARELY ADEQUATE PERFORMANCE, DUE TO PIO TENDENCY
- APPARENT LAG (LIKE A SPRING), NOSE DOWN AT FIRST

Table A.8 - Data Summary Sheets continued

CASE NO. 1A-21-4	SPECS : η_y : OFF ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 21	
RUN/PILOT 5-14-1 / B	SCORES : ε_{long} = .605 σ_{long} = 1.63 ε_{lat} = .18 σ_{lat} = .51	COOPER-HARPER RATING 7+

COMMENTS :

- CONTROLLABILITY OF TASK IN DOUBT
- LAG EFFECTS NOTICABLE AND A VARIABLE FUNCTION OF THE MAGNITUDE OF INPUT
- LOWER GAINS AND SMOOTHING INPUTS

Table A.8 - Data Summary Sheets continued

CASE NO. 1B-11-1	SPECS : η_y : OFF ω_y = - SCAS : ON $K_\bullet$ = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 5	
RUN/PILOT 5-2-5 / B	SCORES : ε_{long} = -.007 σ_{long} = .228 ε_{lat} = .291 σ_{lat} = 1.57	COOPER-HARPER RATING N/A

COMMENTS :

- PILOTS ARE TRAINED TO IGNORE MOTION AND BELIEVE THIER EYES, THEREFORE MOTION AND NO MOTION RESULTS SHOULD BE CLOSE

- SIGMA(P)**2 = 0.77

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-11-2	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : OFF ω_z = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 11	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-7 / B	ε_{long} = -.063 σ_{long} = .298 ε_{lat} = -.034 σ_{lat} = 2.18	N/A

COMMENTS :

- PILOT COMMENTED THAT IN GENERAL, ROLL ALWAYS OVERSHOOTS

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-11-3	η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_x : OFF $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 32	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-8 / B	$\varepsilon_{long} = .84$ $\sigma_{long} = .236$ $\varepsilon_{lat} = .222$ $\sigma_{lat} = 1.19$	3.5

COMMENTS :

- MODERATE PILOT COMPENSATION

- TENDENCY TO OVERSHOOT

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-21-1	η_y : OFF ω_y = - SCAS : ON K_e = 1.6 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 2*	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
4-30-2 / A	ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	N/A

COMMENTS :

- BREAKOUTS AND GRADIENTS IN HARMONY

- SIGMA(P)**2 = 0.77

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-21-2	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD : OFF OLD CASE NO. : 2	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
S-2-2 / B	ε_{long} = .044 σ_{long} = .229 ε_{lat} = -.059 σ_{lat} = 1.83	N/A
COMMENTS :		
- TENDENCY TO CREATE COMPENSATION IN ROLL		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-21-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : OFF $\omega_x = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 8	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-4 / B	$\varepsilon_{long} = -.233$ $\sigma_{long} = .361$ $\varepsilon_{lat} = -.432$ $\sigma_{lat} = 2.71$	N/A

COMMENTS :

- LAG IN ROLL

Table A.8 - Data Summary Sheets continued

CASE NO. 1B-21-3	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : OFF $\omega_x = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 8	
RUN/PILOT 5-7-6 / B	SCORES : $\varepsilon_{long} = .346$ $\sigma_{long} = .343$ $\varepsilon_{lat} = -.137$ $\sigma_{lat} = 1.40$	COOPER-HARPER RATING N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1B-21-4	η_y : ON ω_y = 1.5 SCAS : ON K_q = 2.0 η_x : OFF ω_x = 2. 0 SPEED HOLD ; ON OLD CASE NO. : 31	
RUN/PILOT	**SCORES :**	**COOPER-HARPER RATING**
5-17-7 / B	ε_{long} = .085 σ_{long} = .265 ε_{lat} = -.302 σ_{lat} = 1.33	3

COMMENTS :

- SENSITIVE TO ROLL

- BE CAREFUL NOT TO OVERSHOOT

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-11-1</td><td colspan="2">SPECS :
η_y : OFF ω_y = - SCAS : ON K_q = 2.0
η_z : OFF ω_z = - SPEED HOLD : OFF
OLD CASE NO. : 6</td></tr>
<tr><td>RUN/PILOT

5-2-6 / B</td><td>SCORES :
ε_{long} = -.035 σ_{long} = .325
ε_{lat} = 1.04 σ_{lat} = 1.89</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :

- RELUCTANCE TO DIVE - AMPLIFIES BY ■DOWN■ MOTION

- SIGMA(P)**2 = 0.77</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-1	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 6	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-1 / B	ε_{long} = -.069 σ_{long} = .202 ε_{lat} = .927 σ_{lat} = 2.19	2.5

COMMENTS :

- NOT TOO MUCH PITCH COMPENSATION REQUIRED

- ROLL MAY TAKE A LITTLE (COMPENSATION TO COMPLETE TESK)

- TAU(3) = 0.0

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-1	SPECS : η_y : OFF ω_y = - SCAS : ON K_e = 2.0 η_z : OFF ω_z = - SPEED HOLD : OFF OLD CASE NO. : 6	
RUN/PILOT 5-3-2 / B	SCORES : ε_{long} = .167 σ_{long} = 1.05 ε_{lat} = .171 σ_{lat} = 1.99	COOPER-HARPER RATING N/A

COMMENTS :

- ROLL MORE NOTICEABLE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-1	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD : OFF OLD CASE NO. : 6	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-1 / B	ε_{long} = -.071 σ_{long} = .91 ε_{lat} = .152 σ_{lat} = 1.32	2.5

COMMENTS :

- SLIGHT TENDENCY TO BOBBLE IN PITCH AND ROLL

- C(L(DELTA(S))) MULT = 0.5

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :
1C-11-1	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 6

RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-1 / B	ε_{long} = .026 σ_{long} = 1.01 ε_{lat} = .051 σ_{lat} = 1.36	2.5

COMMENTS :

- COULD PERFORM TASK EASILY

- TECHNIQUE : LIKE AIR-TO-AIR HUD, DON■T FIXATE ON DOT BUT ■LOOK THROUGH■ THE DISLAY SO AS TO SEE ROLL TOO

- TRIED TO BE MORE AGGRESSIVE, LED TO DIMINISHING RETURNS, POSSIBLY IN WORSE LONGITUDINAL SCORES

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-1	η_y : OFF ω_y = - SCAS : ON K_e = 2.0 η_z : OFF ω_z = - SPEED HOLD : OFF OLD CASE NO. : 6	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-31-1 / C	ε_{long} = .154 σ_{long} = .953 ε_{lat} = -.105 σ_{lat} = 1.19	3

COMMENTS :

- HAD TO WORK A LITTLE

- NOTICED PITCH SENSITVITY

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-2	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_e = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 12	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-8 / B	$\varepsilon_{long} = .01$ $\sigma_{long} = 1.24$ $\varepsilon_{lat} = .217$ $\sigma_{lat} = 2.61$	5

COMMENTS :

- DEFINITELY COMPENSATING ON BANK ERROR
- TWO AXIS TASK LEADS TO WORSE ROLL SCORE
- NOT SATISFACTORY PERFORMANCE
- LURCHING AND DISPLAY JUMPING

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-2	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 12	
RUN/PILOT 5-7-3 / B	SCORES : $\varepsilon_{long} = .183$ $\sigma_{long} = 1.34$ $\varepsilon_{lat} = -.056$ $\sigma_{lat} = 1.62$	COOPER-HARPER RATING 5

COMMENTS :

- HAVE TO REST RIGHT ARM ON RIGHT LEG FOR PRECISE INPUTS

- LET OSCILLATIONS DIE OUT, BUT COULD BE AGGRESSIVE

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-2	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 12	
RUN/PILOT 5-29-5 / B	SCORES : $\varepsilon_{long} = .07$ $\sigma_{long} = 1.33$ $\varepsilon_{lat} = .01$ $\sigma_{lat} = 1.19$	COOPER-HARPER RATING 7-8

COMMENTS :

- NOT PUTTING SMOOTH INPUTS IN

- REALLY AGGRESSIVE (NOTICEABLY MORE AGGRESSIVE INPUTS)

- ACQUISITION EASY: FINE TRACKING HARD

- HARD TO CONTROL THIS DISPLAY

- NOT AS "TUNED UP TODAY" REFERING TO HIS TECHNIQUE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :		
1C-11-3	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 2.0 SPEED HOLD ; ON OLD CASE NO. : 13		
RUN/PILOT	SCORES :		COOPER-HARPER RATING
5-3-9 / B	ε_{long} = .166 ε_{lat} = -.077	σ_{long} = 1.12 σ_{lat} = 2.07	4

COMMENTS :

- BANK ANGLE STILL ANNOYING
- TASK EASIER, RESPONSIVE, POOR RATING DUE TO ROLL (A RIGID-BODY PROBLEM PERHAPS)
- NOT CONFUSING DISPLAY, MOTION FELT (PERCEIVED) BUT DISPLAY AS GOOD AS BASILINE
- TWO DISCRETE TASKS (NOT COUPLED)

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-11-3</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON
OLD CASE NO. : 13</td></tr>
<tr><td>RUN/PILOT

5-7-4 / B</td><td>SCORES :
$\varepsilon_{long} = .097$ $\sigma_{long} = 1.24$
$\varepsilon_{lat} = .163$ $\sigma_{lat} = 1.63$</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :

- FREE ARM FED BY MOTION</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD : ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-8 / B	$\varepsilon_{long} = .276$ $\sigma_{long} = 1.58$ $\varepsilon_{lat} = .011$ $\sigma_{lat} = 1.65$	5

COMMENTS :

- MOTION MAY PROVIDE A DAMPING CUE FROM SOUND AND MOTION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD : ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-2 / B	$\varepsilon_{long} = .182$ $\sigma_{long} = 1.13$ $\varepsilon_{lat} = -.07$ $\sigma_{lat} = 1.28$	4

COMMENTS :

- APPLIED LEARNED TECHNIQUE. PART OF HIS COMPENSATION
- INVESTIGATOR THOUGHT IT WAS CASE 1C-21-1 (BY OBSERVING TASK)
- FLYING AGGRESSIVELY BUT SMOOTHLY, DID NOT LET DOT COMPLETELY VIBRATE FREELY BY ■SMOOTHING■
- THE PERFORMANCE WAS AS GOOD AS PREVIOUS RUN BUT CONSIDERABLE COMPENSATION REQUIRED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-2 / B	$\varepsilon_{long} = .079$ $\sigma_{long} = 1.17$ $\varepsilon_{lat} = -.10$ $\sigma_{lat} = 1.14$	5

COMMENTS :

- PILOT CAN CONTROL THE SITUATION AND RIDE IS MUCH SMOOTHER
- VISUAL CUES AID IN CONTROL OF THE SITUATION
- QUALITATIVELY DISCONCERTING THAT SCORES ARE NOT HIGHER (WORSE) SINCE NOTED MORE ERROR
- THE PILOT PERCIEVED WORSE PERFORMANCE AND HIGH WORK LOAD
- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD : ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-21-8 / A	$\varepsilon_{long} = .213$ $\sigma_{long} = 1.26$ $\varepsilon_{lat} = .215$ $\sigma_{lat} = 1.49$	4-5

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-30-1 / C	ε_{long} = -.008 σ_{long} = 1.58 ε_{lat} = .868 σ_{lat} = 2.34	N/A

COMMENTS :

- (ON LEARNING CURVE)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 13	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-30-5 / C	$\varepsilon_{long} = -.085$ $\sigma_{long} = 1.35$ $\varepsilon_{lat} = -.49$ $\sigma_{lat} = 1.79$	5
COMMENTS :		

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-11-4</td><td colspan="2">SPECS :

η_y : ON ω_y = 2.0   SCAS : ON K_q = 2.0

η_x : ON ω_x = 1.75   SPEED HOLD ; ON

OLD CASE NO. : 18</td></tr>
<tr><td>RUN/PILOT

5-8-8 / B</td><td>SCORES :

ε_{long} = .347 σ_{long} = 1.69

ε_{lat} = .103 σ_{lat} = 1.55</td><td>COOPER-
HARPER
RATING

6-7</td></tr>
<tr><td colspan="3">COMMENTS :

- TRIED TO FLY WITH ■OPTIMAIZED■ TECHNIQUE</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-4	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.75$ SPEED HOLD ; ON OLD CASE NO. : 18	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-3 / B	$\varepsilon_{long} = .13$ $\sigma_{long} = 1.42$ $\varepsilon_{lat} = -.036$ $\sigma_{lat} = 1.26$	6.5

COMMENTS :

- NOT QUITE ADEQUATE PERFORMANCE (WORSE THAN COOPER-HARPER 6)

- ON FRINGES OF ADEQUATE TASK PERFORMANCE; HIGH INTENSE EFFORT

- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-11-4</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 1.75$ SPEED HOLD ; ON
OLD CASE NO. : 18</td></tr>
<tr><td>RUN/PILOT

5-10-6 / B</td><td>SCORES :
$\varepsilon_{long} = .173$ $\sigma_{long} = 1.39$
$\varepsilon_{lat} = -.079$ $\sigma_{lat} = 1.26$</td><td>COOPER-
HARPER
RATING

6.5</td></tr>
<tr><td colspan="3">COMMENTS :

- BARLEY OBTAINED ADEQUATE PERFORMANCE

- INTENSE CONCENTRATION REQUIRED

- FIGHT TENDENCY TO PIO

- NOTE : NO DIGITAL DATA</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :
1C-11-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 24

RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-9 / B	$\varepsilon_{long} = .33$ $\sigma_{long} = 1.74$ $\varepsilon_{lat} = .283$ $\sigma_{lat} = 1.52$	7+

COMMENTS :

- CAN POINT THE NOSE WITH RIGID-BODY AND IT STAYS THERE; IN THIS CASE HE CAN'T LET GO
- COMMENTS FOR PREVIOUS RUN APPLY (I.E. RUN NO. 5-10-8)
- CONTROLLABILITY NOT A QUESTION BUT PERFORMANCE IS TERRIBLE; CAN'T DO TASK
- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-5	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 24	
RUN/PILOT 5-14-4 / B	SCORES : $\varepsilon_{long} = .224$ $\sigma_{long} = 1.60$ $\varepsilon_{lat} = -.044$ $\sigma_{lat} = 1.61$	COOPER-HARPER RATING N/A

COMMENTS :

- MOTION CUES HELPFUL

- THOUGH PERFORMANCE WAS BETTER THAN PREVIOUS RUN (I.E. RUN NO. 5-14-3), GAINS WERE HIGHER; CAN GET INTO OSCILLATIONS AND HAVE TO FIGHT NOT FEED THEM

- MOTION HELPS SORT OUT FLEX MOTION SUCH THAT LAGS WERE NOT SO APPARENT

- EASIER TO CONTROL TIGHTER

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 24	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-21-9 / A	$\varepsilon_{long} = .34$ $\sigma_{long} = 1.71$ $\varepsilon_{lat} = -.102$ $\sigma_{lat} = 2.02$	7

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-6	η_y : ON ω_y = 1.5 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 34	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-10 / B	ε_{long} = .112 σ_{long} = 1.06 ε_{lat} = -.12 σ_{lat} = 1.15	4.5

COMMENTS :

- MOTION HELPS DETERMINE WHAT TO CHASE AND WHAT NOT TO
- SOME WING FLEXING NOTICED
- DISPLAY JITTER NOT AS APPEARENT AS IT WAS WHEN WE TESTED LOW FREQUENCY IN LONGITUDINAL AXIS
- HIGH COMPENSATION REQUIRED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-6	η_y : ON ω_y = 1.5 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 34	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-29-6 / B	ε_{long} = .17 σ_{long} = 1.24 ε_{lat} = -.143 σ_{lat} = 1.49	7-8

COMMENTS :

- NOT EXCITING STRUCTURAL MODE
- PITCH AND ROLL RESPONSE BOTH MORE SENSITIVE THAN LAST RUN (I.E. RUN NO. 5-29-5)
- THOUGHT AT FIRST IT WAS NO DIFFERENT THAN LAST RUN
- COPPER-HARPER RATING WAS PRIMARILY DUE TO PITCH

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-6	SPECS : η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 34	
RUN/PILOT 5-30-4 / C	SCORES : $\varepsilon_{long} = -.044$ $\sigma_{long} = 1.42$ $\varepsilon_{lat} = -.251$ $\sigma_{lat} = 2.10$	COOPER-HARPER RATING 5

COMMENTS :

- PIO TENDENCY IN PITCH AND ROLL

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-7	SPECS : η_y : ON $\omega_y = 1.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 40	
RUN/PILOT 5-30-9 / C	SCORES : $\varepsilon_{long} = .192$ $\sigma_{long} = 1.38$ $\varepsilon_{lat} = .152$ $\sigma_{lat} = 1.80$	COOPER-HARPER RATING 4

COMMENTS :

- NOT SURE IF MOTION HELPED IN THIS CASE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-11-7	η_y : ON ω_y = 1.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 40	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-31-2 / C	ε_{long} = .126 σ_{long} = 1.34 ε_{lat} = -.112 σ_{lat} = 1.46	5

COMMENTS :

- JUDGES ADEQUATE PERFORMANCE BUT NOT DESIRED PERFORMANCE ACHIEVED

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-11-8	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 49	
RUN/PILOT 5-21-10/A	SCORES : $\varepsilon_{long} = .41$ $\sigma_{long} = 2.88$ $\varepsilon_{lat} = -.021$ $\sigma_{lat} = 1.97$	COOPER-HARPER RATING N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-3-10 / B	$\varepsilon_{long} = .015$ $\sigma_{long} = 1.16$ $\varepsilon_{lat} = .396$ $\sigma_{lat} = 2.12$	4

COMMENTS :

- PITCH RESPONSE SLIGHTLY WORSE THAN RIGID -BODY

- RATING PRIMARILY DUE TO ROLL PERFORMANCE RATING WOULD HAVE BEEN 3 IF NOT FOR ROLL

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-9 / B	$\varepsilon_{long} = .279$ $\sigma_{long} = 1.02$ $\varepsilon_{lat} = .058$ $\sigma_{lat} = 1.56$	3

COMMENTS :

- BETTER PERFORMANCE

- COMPENSATION IN LEARNING NOT TO PAY ATTENTION TO MOTION

- PREVIOUSLY (WITH FLEXIBLE DISPLAY) COULD USE MOTION TO IDENTIFY BENDING MODE AND IGNORE IT

- PRETTY RESPONSIVE IN PITCH. TASK WAS ~~CLE~~ CLEARLY EASIER THAN WITH FLEXIBLE DISPLAY

- IN THIS CASE, TRIED TO IGNORE THE MOTION

C-2

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-1	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_{\phi} = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT 5-8-3 / B	SCORES : $\varepsilon_{long} = .130$ $\sigma_{long} = 1.09$ $\varepsilon_{lat} = .016$ $\sigma_{lat} = 1.38$	COOPER-HARPER RATING 5

COMMENTS :

- HAD TO UNLEARN TECHNIQUE USED FOR CASE 1C-11-3. PERHAPS OVERCONTROL AS A RESULT

- COMPENSATION LIGHTER. HAD TO MOVE THE STICK SLOWLY

- FELT TASK WAS HARDER. FELT THE MOTION AND NEW IT WAS FLEXIBLE BUT DIFFERENT FROM CASE 1C-11-3

- FELT PERFORMANCE WAS WORSE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-1 / B	$\varepsilon_{long} = .18$ $\sigma_{long} = 1.00$ $\varepsilon_{lat} = -.118$ $\sigma_{lat} = 1.13$	4.5

COMMENTS :

- IDENTIFIED THIS CASE

- QUALITATIVE PERFORMANCE A LITTLE WORSE; HAVE TO SUPPRESS THE MOTION CUES, MOTION IS A DISTRACTION; AWARE OF UNDULATION AND POSSIBLY MOTION FEEDING BACK THROUGH

- DESIRED PERFORMANCE BUT EXCESSIVE WORK LOAD

- MUCH MORE EFFORT, INTENSE CONCENTRATION NEEDED TO OVERCOME THE MOTION SENSATION AND GRIPPING STICK HARD

- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_\phi = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-21-7 / A	$\varepsilon_{long} = .219$ $\sigma_{long} = .906$ $\varepsilon_{lat} = -.018$ $\sigma_{lat} = 1.35$	N/A

COMMENTS :

- AS SYMMETRIC BENDING FREQUENCY DECREASES THE TOTAL RESPONSE DECREASES; THEREFORE THE AEROELASTIC MODE RESPONSE IS NOT AS DRAMATIC
- AEROELASTIC MODE RESPONSE IS NOTICEABLE WITH ABRUPT INPUTS
- TWO PHASE TASK; THERE IS A DIFFERENCE BETWEEN FINE-TRACKING AND TARGET ACQUISITION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 2.0 SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT 5-22-1 / A	SCORES : ε_{long} = -.05 σ_{long} = 1.07 ε_{lat} = .08 σ_{lat} = 1.64	COOPER-HARPER RATING 2-3

COMMENTS :

- PERHAPS SLIGHT LAG. PITCH FAIRLY RESPONSIVE AND PREDICTABLE

- NOTE : NO STRIP CHARTS AVAILABLE BUT DIGITAL DATA IS AVAILABLE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 14.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-1 / A	$\varepsilon_{long} = -.203$ $\sigma_{long} = .954$ $\varepsilon_{lat} = -.01$ $\sigma_{lat} = 1.28$	2-3
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-2	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.75$ SPEED HOLD ; ON OLD CASE NO. : 19	
RUN/PILOT 5-10-4 / B	SCORES : $\varepsilon_{long} = .081$ $\sigma_{long} = .92$ $\varepsilon_{lat} = -.124$ $\sigma_{lat} = 1.17$	COOPER-HARPER RATING 4.5

COMMENTS :

- DELUSION OF REDUCTION IN PITCH-DAMPING: TENDENCY TO OVERSHOOT
- NEARLY OBTAINED DESIRED PERFORMANCE, BUT STILL INTENSE CONCENTRATION NECESSARY
- HARDER THAN CASE 1C-12-1
- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-3	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 25.	
RUN/PILOT 5-14-5 / B	SCORES : $\varepsilon_{long} = .205$ $\sigma_{long} = .959$ $\varepsilon_{lat.} = .111$ $\sigma_{lat} = 1.29$	COOPER-HARPER RATING 2.5

COMMENTS :

- VERY CLOSE TO DESIRED PERFORMANCE
- PIECE OF CAKE
- BASED ON PREVIOUS RUNS OF 5-14 THIS CASE IS PRETTY EASY
- EVALUATOR COMMENT - I COULD SURE FEEL THE VIBRATION MOTION

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-3	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 25.	
RUN/PILOT 5-21-6 / A	SCORES : $\varepsilon_{long} = .20$ $\sigma_{long} = .953$ $\varepsilon_{lat} = -.066$ $\sigma_{lat} = 1.40$	COOPER-HARPER RATING N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 25.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-29-1 / A	$\varepsilon_{long} = .23$ $\sigma_{long} = .952$ $\varepsilon_{lat} = .15$ $\sigma_{lat} = 1.34$	4

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 25.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-2 / A	$\varepsilon_{long} = .028$ $\sigma_{long} = 1.01$ $\varepsilon_{lat} = -.065$ $\sigma_{lat} = 1.36$	2-3

COMMENTS :

- GOOD RESPONSE

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-4	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.25$ SPEED HOLD ; ON OLD CASE NO. : 27	
RUN/PILOT 5-17-1 / B	SCORES : $\varepsilon_{long} = .153$ $\sigma_{long} = 1.02$ $\varepsilon_{lat} = .044$ $\sigma_{lat} = 1.18$	COOPER-HARPER RATING 3

COMMENTS :

- THOUGHT PERFORMANCE WAS BETTER, PERHAPS PEAK DEVIATION LESS THAN PREVIOUS RUN

- RIDE IS STILL ROUGH

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-5	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 29.	
RUN/PILOT 5-17-3 / B	SCORES : $\varepsilon_{long} = .27$ $\sigma_{long} = 1.00$ $\varepsilon_{lat} = .15$ $\sigma_{lat} = 1.2$	COOPER-HARPER RATING 3.5

COMMENTS :

- DISTRACTION TO FEEL VIBRATION

- CLOSE TO DESIRED PERFORMANCE

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-12-5</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_x : ON $\omega_x = 1.0$ SPEED HOLD ; ON
OLD CASE NO. : 29.</td></tr>
<tr><td>RUN/PILOT

S-21-4 / A</td><td>SCORES :
$\varepsilon_{long} = .262$ $\sigma_{long} = 1.05$
$\varepsilon_{lat} = -.084$ $\sigma_{lat} = 1.51$</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 29.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-3 / A	$\varepsilon_{long} = -.035$ $\sigma_{long} = 1.04$ $\varepsilon_{lat} = -.16$ $\sigma_{lat} = 1.36$	N/A

COMMENTS :

- LOW FREQUENCY NORMAL (PLUNGE) UNDULATION NOTICEABLE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 29.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-29-2 / A	$\varepsilon_{long} = .32$ $\sigma_{long} = 1.07$ $\varepsilon_{lat} = .066$ $\sigma_{lat} = 1.43$	4

COMMENTS :

- LOW FREQUENCY PLUNGE SENSATION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-6	η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 35	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-11 / B	$\varepsilon_{long} = .131$ $\sigma_{long} = .797$ $\varepsilon_{lat} = -.038$ $\sigma_{lat} = 1.15$	3.5

COMMENTS :

- CONSISTENT WITH PREVIOUS RESULTS
- PERFORMANCE BECOMES SOMEWHAT INDEPENDENT FROM CASE TO CASE
- VARIATION WITH MOTION CAN BE FELT
- IN ROLL: TENDENCY TO OVERSHOOT
- CAN EXCITE LATERAL MODE LEADING TO PIO

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-6	SPECS : η_y : ON ω_y = 1.5 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 35	
RUN/PILOT 5-29-7 / B	SCORES : ε_{long} = .12 σ_{long} = .86 ε_{lat} = -.06 σ_{lat} = 1.29	COOPER-HARPER RATING 4

COMMENTS :

- ROLL DIFFICULTIES WERE MORE APPEARENT: ROLL RESPONSE HAD LESS DAMPING AND WAS HARDER TO CONTROL

- HAD TO FIGHT TO KEEP PITCH PERFORMANCE UP

- HAD TO CONDENTRATE ON ROLL TASK, WHERE AS IN BASELINE ROLL TASK WAS ALMOST AUTOMATIC

- INCREASED ROLL SENSITIVITY, OR REDUCED ROLL DAMPING: OVERHSOOT AND 2-3 ROLL CORRECTIONS REQUIRED

- PIO TENDENCY IN ROLL

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-6	SPECS : η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 35	
RUN/PILOT 5-30-6 / C	SCORES : $\varepsilon_{long} = .070$ $\sigma_{long} = 1.00$ $\varepsilon_{lat} = -.362$ $\sigma_{lat} = 1.51$	COOPER-HARPER RATING 3-4

COMMENTS :

- MUCH EASIER TASK THAN LAST TWO (I.E. RUN NO. 5-30-4 AND 5-30-5)

- HAD TO WORK HARDER THAN WOULD LIKE TO

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-7	SPECS : η_y : ON $\omega_y = 1.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 41	
RUN/PILOT 5-31-3/C	SCORES : $\varepsilon_{long} = .049$ $\sigma_{long} = .985$ $\varepsilon_{lat} = -.516$ $\sigma_{lat} = 1.64$	COOPER-HARPER RATING 4-5

COMMENTS :

- TASK EASIER THAN LAST RUN BUT STILL WORK ING HARD

- MOTION MIGHT NOT HAVE HELPED

- MODERATE TO HEAVY COMPENSATION REQUIRED

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-12-8</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 0.8$ SPEED HOLD ; ON
OLD CASE NO. : 45.</td></tr>
<tr><td>RUN/PILOT
S-21-1 / A</td><td>SCORES :
$\varepsilon_{long} = -.24$ $\sigma_{long} = 1.64$
$\varepsilon_{lat} = -.25$ $\sigma_{lat} = 1.70$</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-8	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 0.8$ SPEED HOLD ; ON OLD CASE NO. : 45.	
RUN/PILOT	**SCORES :**	**COOPER-HARPER RATING**
5-21-3 / A	$\varepsilon_{long} = .006$ $\sigma_{long} = 1.48$ $\varepsilon_{lat} = -.143$ $\sigma_{lat} = 1.79$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-12-8</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 0.8$ SPEED HOLD ; ON
OLD CASE NO. : 45.</td></tr>
<tr><td>RUN/PILOT

S-24-4 / A</td><td>SCORES :
$\varepsilon_{long} = -.25$ $\sigma_{long} = 1.37$
$\varepsilon_{lat} = -.077$ $\sigma_{lat} = 1.57$</td><td>COOPER-HARPER RATING

4-5</td></tr>
<tr><td colspan="3">COMMENTS :

- LOW FREQUENCY LIGHTLY DAMPED

- PERHAPS FLEW A LITTLE TENTATIVELY BECAUSE OF ODD (LOW FREQUENCY) MOTION AND WAS APPREHENSIVE AS A RESULT</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-8	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 0.8$ SPEED HOLD ; ON OLD CASE NO. : 45.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-29-4 / A	$\varepsilon_{long} = -.24$ $\sigma_{long} = 1.30$ $\varepsilon_{lat} = .15$ $\sigma_{lat} = 1.36$	5

COMMENTS :

- HEAVIER FORCES

- LESS PREDICTABLE

- UNSTABLE PHUGOID NOTED BUT NOT CONTROLLED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-9	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 0.9$ SPEED HOLD ; ON OLD CASE NO. : 46	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-21-2 / A	$\varepsilon_{long} = .287$ $\sigma_{long} = 1.05$ $\varepsilon_{lat} = .058$ $\sigma_{lat} = 1.40$	N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-10	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 1.6$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 54	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-5 / A	$\varepsilon_{long} = .281$ $\sigma_{long} = .995$ $\varepsilon_{lat} = -.227$ $\sigma_{lat} = 1.08$	3

COMMENTS :

- LITTLE OSCILLATORY TENDENCY

- STICK MORE SENSITIVE (THAN PREVIOUS RUNS I.E. RUNS 5-24-1 - 5-24-4)

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-12-10	SPECS : η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 54	
RUN/PILOT 5-24-9 / B	SCORES : ε_{long} = .080 σ_{long} = .839 ε_{lat} = -.130 σ_{lat} = 1.08	COOPER-HARPER RATING 3

COMMENTS :

- LITTLE OVERSHOOT

- MUST BE CAREFUL NOT TO OVERCONTROL

- FREQUENCY OF VIBRATION NOT DISTRACTING

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-11	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 55	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-6 / A	ε_{long} = -.034 σ_{long} = 1.00 ε_{lat} = -.038 σ_{lat} = 1.18	2.5

COMMENTS :

- PRETTY GOOD RESPONSE
- NOT TOO SENSITIVE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-11	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 1.6$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 55	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-10 / B	$\varepsilon_{long} = .13$ $\sigma_{long} = 1.03$ $\varepsilon_{lat} = .054$ $\sigma_{lat} = .895$	3+

COMMENTS :

- ACQUISITION NOMINAL

- OSCILLATIONS TEND TO BE ANNOYING

- HAD TO MENTALLY SUPRESS THE ANNOYANCE (SENSATION)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-12	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_z : ON ω_z = 1.0 SPEED HOLD ; ON OLD CASE NO. : 56	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-7 / A	ε_{long} = -.040 σ_{long} = 1.0 ε_{lat} = -.074 σ_{lat} = 1.37	3.5

COMMENTS :

- MORE DIFFICULT TO CONTROL (THAN PREVIOUS RUN)

- SICKENING MOTION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-12	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 1.6$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 56	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-11/B	$\varepsilon_{long} = .054$ $\sigma_{long} = .895$ $\varepsilon_{lat} = -.004$ $\sigma_{lat} = 1.10$	N/A

COMMENTS :

- TASK SEEMED A LITTLE TOUGHER (THAN PREVIOUS RUNS)

- NOT SURE IF ENTIRELY DUE TO MOTION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-13	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_z : ON ω_z = 0.8 SPEED HOLD ; ON OLD CASE NO. : 57	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-8 / A	ε_{long} = -.145 σ_{long} = 1.27 ε_{lat} = -.017 σ_{lat} = 1.32	5

COMMENTS :

- MUCH HARDER (THAN PREVIOUS RUNS)

- WEIRD MOTION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-13	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_z : ON ω_z = 0.8 SPEED HOLD ; ON OLD CASE NO. : 57	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
S-24-13 / B	ε_{long} = .058 σ_{long} = 1.21 ε_{lat} = -.66 σ_{lat} = 1.11	5

COMMENTS :

- SIGNIFICANT DEGREDATION IN PERFORMANCE
- MORE DIFFICULT TO ACQUIRE TARGET
- SLUGGISH
- MORE STICK DEFLECTION REQUIRED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-14	η_y : ON $\omega_y = 2.0$ SCAS : OFF K_q = - η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 58	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-14 / B	$\varepsilon_{long} = .023$ $\sigma_{long} = 1.18$ $\varepsilon_{lat} = -.12$ $\sigma_{lat} = 1.32$	5

COMMENTS :

- SLUGGISH

- HEAVY, LARGE STICK DISPLACEMENTS

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-12-15</td><td colspan="2">SPECS :
η_y : ON ω_y = 2.0 SCAS : OFF K_s = -
η_x : ON ω_x = 1.5 SPEED HOLD ; ON
OLD CASE NO. : 59</td></tr>
<tr><td>RUN/PILOT

5-24-15/B</td><td>SCORES :
ε_{long} = -.014 σ_{long} = 1.35
ε_{lat} = -.016 σ_{lat} = 1.30</td><td>COOPER-HARPER RATING

6</td></tr>
<tr><td colspan="3">COMMENTS :

- SLUGGISH

- HEAVY, LARGE STICK DISPLACEMENTS

- LESS PREDICTABLE

- LARGER OVERSHOOT IN CORRECTIONS</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-16	η_y : ON ω_y = 2.0 SCAS : OFF K_q = - η_z : ON ω_z = 1.0 SPEED HOLD ; ON OLD CASE NO. : 60	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-16/B	ε_{long} = .059 σ_{long} = 1.35 ε_{lat} = -.20 σ_{lat} = 1.21	6

COMMENTS :

- SIMILAR TO LAST RUN

- DID NOT SEEM TO BE JUMPING QUITE AS BAD

- LARGE FORCES AND DISPLACEMENTS

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-12-17	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; ON OLD CASE NO. : 29*	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-4 / B	ε_{long} = .08 σ_{long} = .84 ε_{lat} = .033 σ_{lat} = 1.15	2.5

COMMENTS :

- MOTION A DISTRACTION BECAUSE FELT SURGE (U) IN DIVE; PILOTS ARE WARY

- DESIRED PERFORMANCE ACHIEVED

- PITCH A LITTLE LIGHTER IN RESPONSE SO MAY BE TENDENCY TO OVERSHOOT

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-1	η_y : OFF ω_y = - SCAS : ON K_q = 1.6 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 3*	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
4-30-3 / A	ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	5

COMMENTS :

- INTERESTING THING IS AN OSCILLATION IS SET UP WHEN TRYING TO RECOVER BOTH AXES THAT DID NOT OCCUR IN CASE 1B-21-2

- CAN NOT DIVERT ATTENTION OR ELSE A FEW OVERSHOOTS

- WILL TRY TO ADJUST KQ IN PITCH SCAS TO ELIMINATE BOBBLE

- NOTE : SIGMA(P)**2 = 0.77 FOR THIS RUN

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-21-2	SPECS : η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 3	
RUN/PILOT 5-2-3 / B	SCORES : ε_{long} = .114 σ_{long} = 1.00 ε_{lat} = .046 σ_{lat} = 1.84	COOPER-HARPER RATING 4

COMMENTS :

- NOTE : SIGMA(P)**2 = 0.77 FOR THIS RUN

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-21-3</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF
OLD CASE NO. : 9,1</td></tr>
<tr><td>RUN/PILOT
5-3-5 / B</td><td>SCORES :
$\varepsilon_{long} = .315$ $\sigma_{long} = 1.36$
$\varepsilon_{lat} = -5.25$ $\sigma_{lat} = 2.53$</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :

- OSCILLATIONS STAY WITHIN CIRCLE

- JUST LET IT DAMPEN OUT SINCE CAN NOT CONTROL IT</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 9.1	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-7-7 / B	$\varepsilon_{long} = .565$ $\sigma_{long} = 1.62$ $\varepsilon_{lat} = .308$ $\sigma_{lat} = 1.92$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-3	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 9.1	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-3 / D	ε_{long} = .419 σ_{long} = 1.53 ε_{lat} = -.57 σ_{lat} = 2.25	N/A

COMMENTS :

- MORE OSCILLATION IS DISPLAY COMPARED TO TWO PREVIOUS RUNS

- DEGRADED PERFORMANCE COMPARED TO TWO PREVIOUS RUNS

- ROLL OVERSHOOT

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-4	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.75$ SPEED HOLD : ON OLD CASE NO. : 17	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-6 / B	$\varepsilon_{long} = .162$ $\sigma_{long} = 1.69$ $\varepsilon_{lat} = -.11$ $\sigma_{lat} = 1.41$	N/A

COMMENTS :

- TRIED TO BE AS AGGRESSIVE AS POSSIBLE

- TRYING TO STAY CENTERED ON TARGET WITH OSCILLATIONS ON EITHER SIDE OF THE DOT. OBVIOUS DUE TO VIBRATION

- ROLL STILL NOT A PROBLEM - CONCENTRATE ON PITCH

- USED MECHANICAL TECHNIQUE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-4	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.75$ SPEED HOLD ; ON OLD CASE NO. : 17	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-8-7 / B	$\varepsilon_{long} = .429$ $\sigma_{long} = 1.53$ $\varepsilon_{lat} = -.25$ $\sigma_{lat} = 1.51$	N/A

COMMENTS :

- ATTEMPTED TO FLY AS SMOOTHLY AS POSSIBLE TO AVOID EXCITATION OF MODES

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 23	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-14-3 / B	$\varepsilon_{long} = .474$ $\sigma_{long} = 1.82$ $\varepsilon_{lat} = .364$ $\sigma_{lat} = 1.64$	7+

COMMENTS :

- APPARENT LAG VERY ANNOYING
- EXTREME STICK DISPLACEMENTS REQUIRED TO GET NOSE MOVING
- TENDS TO PIO
- ROLL DOES NOT SEEM TO AFFECT MY PERFORMANCE OR THE TASK

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-21-6	SPECS : η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 33	
RUN/PILOT 5-17-9 / B	SCORES : $\varepsilon_{long} = .12$ $\sigma_{long} = 1.39$ $\varepsilon_{lat} = -.167$ $\sigma_{lat} = 1.68$	COOPER-HARPER RATING 7

COMMENTS :

- HARD TO ROLL; ROLL OBVIOUSLY DEGRADED
- HARD TO FLY INSTINCTIVELY (AS BEFORE)
- PERFORMANCE VERY BAD

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-6	η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 33	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-30-2 / C	$\varepsilon_{long} = .224$ $\sigma_{long} = 1.49$ $\varepsilon_{lat} = .32$ $\sigma_{lat} = 2.08$	N/A

COMMENTS :

- (ON LEARNING CURVE)

- MENTALLY TRIED HARDER THAN PREVIOULY

- FELT PERFOMANCE WAS BETTER THAN PREVIOUS RUN

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-21-6	SPECS : η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 33	
RUN/PILOT 5-30-3 / C	SCORES : $\varepsilon_{long} = .244$ $\sigma_{long} = 1.45$ $\varepsilon_{lat} = .751$ $\sigma_{lat} = 1.95$	COOPER-HARPER RATING N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-7	η_y : ON ω_y = 1.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 39	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-29-8 / B	ε_{long} = .227 σ_{long} = 1.42 ε_{lat} = -.264 σ_{lat} = 1.74	7.5

COMMENTS :

- HARD TO TELL WHETHER PITCH OR ROLL IS THE PREBLEM WITH SIMULTANEOUS TASKS BEING FLOWN

- DIFFICULT CONFIGURATION TO CONTROL

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-7	η_y : ON $\omega_y = 1.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 39	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-30-8 / C	$\varepsilon_{long} = .18$ $\sigma_{long} = 1.31$ $\varepsilon_{lat} = .156$ $\sigma_{lat} = 1.76$	5

COMMENTS :

- A LITTLE TOUGHER THAN LAST RUN
- FELT LIKE MORE RUDDER EFFECTIVENESS
- AILERON FELT THE SAME

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-8	η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 113	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-4 / D	$\varepsilon_{long} = -.049$ $\sigma_{long} = 2.63$ $\varepsilon_{lat} = -.323$ $\sigma_{lat} = 2.94$	N/A

COMMENTS :

- TASK WAS VERY DIFFICULT

- PERFORMANCE UNACCEPTABLE

- LARGE STICK DISPLACEMENTS REQUIRED

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-21-8	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 113	
RUN/PILOT 6-11-5 / D	SCORES : $\varepsilon_{long} = -.161$ $\sigma_{long} = 2.05$ $\varepsilon_{lat} = .592$ $\sigma_{lat} = 3.34$	COOPER-HARPER RATING N/A

COMMENTS :

- UNACCEPTABLE PERFORMANCE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-21-8	η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 113	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-9 / C	$\varepsilon_{long} = -.027$ $\sigma_{long} = 2.85$ $\varepsilon_{lat} = -.704$ $\sigma_{lat} = 2.19$	8+

COMMENTS :

- LARGE STICK INPUTS
- OVERSHOOT PROBLEM
- SLUGGISH RESPONSE
- VERY HARD TASK; UNACCEPTABLE PERFORMANCE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-1	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 20	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-10-5 / B	ε_{long} = .11 σ_{long} = 1.04 ε_{lat} = -.179 σ_{lat} = 1.29	3.5

COMMENTS :

- DESIRED PERFORMANCE OBTAINED WITH COMFORTABLE WORKLOAD

- ONLY SLIGHT TENDENCY TO OVERCONTROL IN PITCH

- NOTE : NO DIGITAL DATA

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-2	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 26	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-14-6 / B	$\varepsilon_{long} = .201$ $\sigma_{long} = .904$ $\varepsilon_{lat} = -.131$ $\sigma_{lat} = 1.32$	2.5

COMMENTS :

- PERFORMANCE ABOUT THE SAME AS CASE 1C-12-3 (PREVIOUS RUN) BUT MUCH MORE PLEASANT TASK

- NO BOUNCING

- PERHAPS SUBTLE LAGS

- NOT QUITE DESIRED PERFORMANCE, BUT PRETTY CLOSE

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-22-3	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.25$ SPEED HOLD ; ON OLD CASE NO. : 28	
RUN/PILOT 5-17-2 / B	SCORES : $\varepsilon_{long} = .144$ $\sigma_{long} = .82$ $\varepsilon_{lat} = .044$ $\sigma_{lat} = 1.10$	COOPER-HARPER RATING 2.5

COMMENTS :

- HINT OF PIO TENDENCY

- KEPT GAINS HIGH BUT REALLY CLOSE TO BASELINE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-3	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.25 SPEED HOLD ; ON OLD CASE NO. : 28	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
S-17-5 / B	ε_{long} = .313 σ_{long} = 1.11 ε_{lat} = -.032 σ_{lat} = 1.31	3.5

COMMENTS :

- SENSITIVITY: MORE OF A TENDENCY TO OVERSHOOT
- FELT HE DID NOT GET IN A GROOVE
- HAD SOME TROUBLE OSCILLATING ABOUT TARGET
- NO MOTION PUTS YOU TO SLEEP

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-4	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 30	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-6 / B	$\varepsilon_{long} = .16$ $\sigma_{long} = .86$ $\varepsilon_{lat} = .18$ $\sigma_{lat} = 1.12$	3.5

COMMENTS :

- HAD TO BE SMOOTH TO GET HIGH GAINS, TO BE TIGHT

- INTENT ON KEEPING GAINS HIGH BUT STILL BE SMOOTH

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-5	η_y : ON $\omega_y = 1.5$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD : ON OLD CASE NO. : 36	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-17-12 / B	$\varepsilon_{long} = .127$ $\sigma_{long} = .822$ $\varepsilon_{lat} = -.278$ $\sigma_{lat} = 1.11$	4

COMMENTS :

- HARD TO STAY AGGRESSIVE; WANT TO GO TO SLEEP WITH NO MOTION
- INTENSE CONCENTRATION NEEDE TO GET DESIRED PERFORMANCE
- LIGHT FORCES IN ROLL; HAD TO CONCENTRATE TO KEEP SMOOTH

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-5	η_y : ON ω_y = 1.5 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 36	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-30-7 / C	ε_{long} = .085 σ_{long} = 1.04 ε_{lat} = -.157 σ_{lat} = 1.46	3.5

COMMENTS :

- LIKES THE MOTION. IT HELPS (REFERING TO COMPARISON WITH PREVIOUS RUNS)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-6	η_y : ON $\omega_y = 1.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 42	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
S-31-4 / C	$\varepsilon_{long} = .107$ $\sigma_{long} = .980$ $\varepsilon_{lat} = -.570$ $\sigma_{lat} = 1.47$	4

COMMENTS :

- LITTLE HARDER THAN CONFIG. 1C-11-1

- LESS PREDICTABLE IN ROLL

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-7	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_x : ON ω_x = 1.0 SPEED HOLD : ON OLD CASE NO. : 56B	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-24-12/B	ε_{long} = .41 σ_{long} = 1.5 ε_{lat} = -.299 σ_{lat} = 1.49	4

COMMENTS :

- PITCH WAS NOT WELL BEHAVED (AS PREVIOUS RUNS)

- NOT ENTIRELY DUE TO MOTION (REFERING TO COMMENTS FOR PREVIOUS RUN)

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-22-8	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 0.8$ SPEED HOLD ; ON OLD CASE NO. : 45B	
RUN/PILOT 5-29-3 / A	SCORES : $\varepsilon_{long} = -.23$ $\sigma_{long} = 1.33$ $\varepsilon_{lat} = .19$ $\sigma_{lat} = 1.50$	COOPER-HARPER RATING 5
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-9	η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_x : ON $\omega_x = 1.5$ SPEED HOLD ; OFF OLD CASE NO. : 75	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-3-1 / A	$\varepsilon_{long} = .38$ $\sigma_{long} = 1.29$ $\varepsilon_{lat} = -.32$ $\sigma_{lat} = 2.04$	N/A

COMMENTS :

- STICK: SEEMS TO RUN OUT OF CONTROL POWER

- GOOD RESPONSE OTHERWISE

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-22-9	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_x : ON $\omega_x = 1.5$ SPEED HOLD ; OFF OLD CASE NO. : 75	
RUN/PILOT 6-4-1 / A	SCORES : $\varepsilon_{long} = .203$ $\sigma_{long} = 1.05$ $\varepsilon_{lat} = -.082$ $\sigma_{lat} = 1.77$	COOPER-HARPER RATING N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-9	η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_z : ON $\omega_z = 1.5$ SPEED HOLD ; OFF OLD CASE NO. : 75	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-3 / A	$\varepsilon_{long} = 1.81$ $\sigma_{long} = 1.02$ $\varepsilon_{lat} = -.275$ $\sigma_{lat} = 1.48$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-10	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; OFF OLD CASE NO. : 76	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-3-2 / A	$\varepsilon_{long} = -.39$ $\sigma_{long} = 1.15$ $\varepsilon_{lat} = .258$ $\sigma_{lat} = 1.57$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-10	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.5$ SPEED HOLD : OFF OLD CASE NO. : 76	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-2 / A	$\varepsilon_{long} = -.047$ $\sigma_{long} = .91$ $\varepsilon_{lat} = .023$ $\sigma_{lat} = 1.47$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-22-11	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 77.	
RUN/PILOT 6-3-3 / A	SCORES : $\varepsilon_{long} = -.001$ $\sigma_{long} = .88$ $\varepsilon_{lat} = .098$ $\sigma_{lat} = 1.41$	COOPER-HARPER RATING N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

1C-22-11</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF
OLD CASE NO. : 77.</td></tr>
<tr><td>RUN/PILOT
6-4-4 / A</td><td>SCORES :
$\varepsilon_{long} = .013$ $\sigma_{long} = .96$
$\varepsilon_{lat} = -.066$ $\sigma_{lat} = 1.41$</td><td>COOPER-HARPER RATING

N/A</td></tr>
<tr><td colspan="3">COMMENTS :</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-11	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 77.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-2 / D	ε_{long} = .068 σ_{long} = 1.30 ε_{lat} = -.495 σ_{lat} = 2.22	N/A

COMMENTS :

- NO DISCERNNABLE DIFFERENCE IN PERFORMANCE COMPARED TO PREVIOUS RUN

- SAME SLIGHT ROLL OVERSHOOT

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-11	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 77.	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-7 / C	$\varepsilon_{long} = .399$ $\sigma_{long} = 1.15$ $\varepsilon_{lat} = -.423$ $\sigma_{lat} = 1.94$	N/A

COMMENTS :

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-12	η_y : ON ω_y = 2.0 SCAS : ON K_q = ESC η_z : ON ω_z = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 112	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-1 / D	ε_{long} = .087 σ_{long} = 1.34 ε_{lat} = -.09 σ_{lat} = 2.85	N/A

COMMENTS :

- SLIGHT ROLL OVERSHOOT

- PERFORMANCE ACCEPTABLE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
1C-22-12	η_y : ON ω_y = 2.0 SCAS : ON K_q = ESC η_z : ON ω_z = 2.0 SPEED HOLD ; OFF OLD CASE NO. : 112	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-6 / D	ε_{long} = .196 σ_{long} = 1.29 ε_{lat} = -.20 σ_{lat} = 2.35	N/A
COMMENTS :		

Table A.8 - Data Summary Sheets continued

CASE NO. 1C-22-12	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON K_q = ESC η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 112	
RUN/PILOT 6-11-8 / C	SCORES : $\varepsilon_{long} = .257$ $\sigma_{long} = 1.17$ $\varepsilon_{lat} = -.229$ $\sigma_{lat} = 1.85$	COOPER-HARPER RATING N/A

COMMENTS :

- NO OBVIOUS DIFFERENCE FROM LAST RUN

- THIS RUN MIGHT BE LESS SQUIRRELY

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-1	η_y : OFF ω_y = - SCAS : ON K_q = 1.6 η_z : OFF ω_z = - SPEED HOLD ; ON OLD CASE NO. : 61	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
S-31-5 / C	ε_{long} = .066 σ_{long} = .513 ε_{lat} = -.270 σ_{lat} = .205	2

COMMENTS :

- ACHIEVED DESIRED PERFORMANCE

- NOTE : SIGMA(P)**2 = 0.1 ; OMEGA(R) = OMEGA(P) = 0.5

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-2	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_x : ON ω_x = 2.0 SPEED HOLD ; ON OLD CASE NO. : 62	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-31-6 / C	ε_{long} = .066 σ_{long} = .456 ε_{lat} = -.213 σ_{lat} = .210	N/A

COMMENTS :

- TARGET VIBRATES WITH A/C SYMBOL; NO REAL CONFUSION

- NOTE : SIGMA(P)**2 = 0.1 ; OMEGA(R) = OMEGA(P) = 0.5

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-3	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 1.6$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 63	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-31-7 / C	$\varepsilon_{long} = .017$ $\sigma_{long} = .60$ $\varepsilon_{lat} = -.172$ $\sigma_{lat} = .311$	N/A

COMMENTS :

- NOTE : SIGMA(P)**2 = 0.2 ; OMEGA(R) = OMEGA(P) = 0.5

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-4	η_y : ON ω_y = 2.0 SCAS : ON K_q = 1.6 η_x : ON ω_x = 2.0 SPEED HOLD ; ON OLD CASE NO. : 64	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
5-31-8 / C	ε_{long} = -.111 σ_{long} = .735 ε_{lat} = -.181 σ_{lat} = .298	4

COMMENTS :

- HAD TO BE CAREFUL

- NOTE : SIGMA(P)**2 = 0.3 ; OMEGA(R) = OMEGA(P) = 0.5

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-5	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 2.0$ SPEED HOLD : ON OLD CASE NO. : 78	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-3-4 / C	$\varepsilon_{long} = .013$ $\sigma_{long} = .702$ $\varepsilon_{lat} = -.036$ $\sigma_{lat} = .291$	4.5

COMMENTS :

- STICK FORCES ARE A LITTLE HEAVY
- GOOD TRACKING PERFORMANCE WITHOUT MUCH DIFFICULTY
- MOTION IS A DISTRACTION; BUT DOES NOT SEEM TO AFFECT PERFORMANCE
- ROLL OSCILLATIONS; MODERATELY OBJECTION-ABLE; CAUSES TENTATIVE USE OF AILERON, USE RUDDER TO COMPENSATE

Table A.8 - Data Summary Sheets continued

<table>
<tr><td>CASE NO.

2C-11-5</td><td colspan="2">SPECS :
η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$
η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON
OLD CASE NO. : 78</td></tr>
<tr><td>RUN/PILOT

6-4-7 / C</td><td>SCORES :
$\varepsilon_{long} = .061$ $\sigma_{long} = .58$
$\varepsilon_{lat} = -.112$ $\sigma_{lat} = .203$</td><td>COOPER-HARPER RATING

4</td></tr>
<tr><td colspan="3">COMMENTS :

- FINE TUNES HEADING ERROR WITH RUDDER; GROSS CORRECTION WITH AILERON (MINIMIZES ROLL OSCILLATIONS)

- DEFINITE INCREASE IN PERFORMANCE (OVER PREVIOUS RUN)

- WORKED AS HARD WITH BETTER RESULTS

- ROLL MOTION IS BOTHERSOME, JERKY</td></tr>
</table>

Table A.8 - Data Summary Sheets continued

CASE NO. 2C-11-6	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 79.	
RUN/PILOT 6-3-5 / C	SCORES : $\varepsilon_{long} = .26$ $\sigma_{long} = 1.21$ $\varepsilon_{lat} = -.332$ $\sigma_{lat} = .270$	COOPER-HARPER RATING 5

COMMENTS :

- STICK FORCES SAME AS LAST RUN
- FELT PERFORMANCE WAS WORSE THAN SCORES INDICATE
- MOTION IS DISTRACTING; EFFECT ON PERFORM1ANCE IS QUESTIONABLE
- AWARE OF ROLL OSCILLATIONS AND SO AVOIDS EXCITING THEM

Table A.8 - Data Summary Sheets continued

CASE NO. 2C-11-6	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 79	
RUN/PILOT 6-4-11 / C	SCORES : $\varepsilon_{long} = .058$ $\sigma_{long} = .650$ $\varepsilon_{lat} = -.172$ $\sigma_{lat} = .279$	COOPER-HARPER RATING 4.5

COMMENTS :

- LOW RUDDER RESPONSE
- CAN NOT SEEM TO OBTAIN PERFORMANCE THAT SEEMS TO BE ACHIEVABLE
- ANNOYING LONGITUDINAL VIBRATION

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-7	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.0 SPEED HOLD ; ON OLD CASE NO. : 80	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-3-6 / C	ε_{long} = -.017 σ_{long} = .785 ε_{lat} = -.406 σ_{lat} = .427	5

COMMENTS :

- STICK FORCES SEEMED HEAVIER; MORE PITCH, AILERON AND RUDDER ACTIVITY WERE REQUIRED TO OBTAIN PERFORMANCE
- MOTION IS ANNOYING
- ROLL OSCILLATIONS LESS NOTICEABLE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-7	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.0 SPEED HOLD ; ON OLD CASE NO. : 80	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-6 / C	ε_{long} = -.113 σ_{long} = .709 ε_{lat} = -.153 σ_{lat} = .339	5

COMMENTS :

- TASK WAS DO-ABLE
- USED MOTION CUES BUT DID NOT CONSCIOUSLY KEY ON IT
- IGNORE HORIZON MOTION IN DISPLAY
- SLIGHT RESPONSE LAG

Table A.8 - Data Summary Sheets continued

CASE NO. 2C-11-8	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 91	
RUN/PILOT 6-6-2 / C	SCORES : $\varepsilon_{long} = .006$ $\sigma_{long} = .59$ $\varepsilon_{lat} = -.143$ $\sigma_{lat} = .198$	COOPER-HARPER RATING 4.5

COMMENTS :

- NO MAJOR DEFICIENCIES
- FELT LATERAL MOTION ANNOYING; UNREALISTIC
- SLIGHTLY MORE DIFFICULT THAN PREVIOUS RUN
- FLEX MODE SEEMS SLIGHTLY DIFFERENT
- FELT HE WAS WORKING HARDER

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-9	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; OFF OLD CASE NO. : 92	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-3 / C	$\varepsilon_{long} = -.12$ $\sigma_{long} = .654$ $\varepsilon_{lat} = -.176$ $\sigma_{lat} = .264$	5

COMMENTS :

- DECREASE IN RESPONSIVENESS TO STICK (COMPARED TO PREVIOUS RUN)
- FELT PERFORMANCE WAS WORSE FOR THIS RUN (COMPARED TO PREVIOUS RUN)
- IGNORING HORIZON MOTION IN DISPLAY

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-10	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.0 SPEED HOLD ; OFF OLD CASE NO. : 93	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-4 / C	ε_{long} = -.031 σ_{long} = .785 ε_{lat} = -.236 σ_{lat} = .258	6

COMMENTS :

- VERY OBJECTIONABLE, SLUGGISH BEHAVIOR
- COULD COMPENSATE FOR DEFICIENCIES, FELT HE COULD DO BETTER WITH PRACTICE
- NOT AS RESPONSIVE TO STICK, MORE LEAD REQUIRED DUE TO INCREASED SLUGGISHNESS (COMPARED TO LAST FEW PREVIOUS RUNS)
- IGNORING HORIZON DISPLAY MOTION
- HAD TO BE MORE AGGRESSIVE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-11	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 93B	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-6 / C	$\varepsilon_{long} = .122$ $\sigma_{long} = .722$ $\varepsilon_{lat} = -.28$ $\sigma_{lat} = .25$	6

COMMENTS :

- EXTENSIVE PILOT COMPENSATION REQUIRED
- PIO TENDENCIES; TRIED TO PUT IN SMOOTH INPUTS TO NOT EXCITE OSCILLATIONS (IN BOTH AXES)
- TASK REQUIRED MORE STICK ACTIVITY
- IF TARGET GETS AWAY, A LARGER INPUT CAUSES A CHASING GAME
- SPEED HOLD EFFECTS NOTICED

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-12	η_y : ON ω_y = 2.0 SCAS : ON K_e = 2.0 η_z : ON ω_z = 0.8 SPEED HOLD ; OFF OLD CASE NO. : 94	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-5 / C	ε_{long} = -.031 σ_{long} = .78 ε_{lat} = -.21 σ_{lat} = .264	6

COMMENTS :

- TRYING TO PUT IN SMOOTH INPUTS IN LATERAL STICK TO NOT EXCITE OSCILLATIONS
- IF HE STAYS CLOSE TO TARGET - OK, BUT IF IT GETS AWAY FROM HIM HE HAS TROUBLE GETTING BACK TO IT
- MORE DIFFICULT THAN PREVIOUS RUN
- CONTROL EFFECTIVENESS ABOUT THE SAME AS LAST RUN
- LEAD REQUIRED IN BOTH AXES

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-11-13	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 0.8 SPEED HOLD ; ON OLD CASE NO. : 94B	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-7 / C	ε_{long} = .012 σ_{long} = .765 ε_{lat} = -.204 σ_{lat} = .292	6

COMMENTS :

- TASK REQUIRED SIGNIFICANT PILOT WORKLOAD
- NO NOTICE OF SPEED HOLD EFFECTS
- IGNORING HORIZON DISPLAY MOTION
- SOMETIMES FEELS COMBINATION OF CAB MOTION AND HORIZON MOTION CONFUSING
- THINKS MOTION IS CONFUSING

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-1	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 2.0 SPEED HOLD ; ON OLD CASE NO. : 82	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-8 / C	ε_{long} = .033 σ_{long} = .61 ε_{lat} = -.118 σ_{lat} = .173	4

COMMENTS :

- DID NOT NOTICE ANY DIFFERENCE OVER PREVIOUS RUN

- COMMENTS FROM PREVIOUS RUN APPLY IN THIS RUN TOO

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-2	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 83	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-9 / C	$\varepsilon_{long} = .031$ $\sigma_{long} = .634$ $\varepsilon_{lat} = -.127$ $\sigma_{lat} = .294$	5

COMMENTS :

- MORE COMPENSATION THAN PREVIOUS RUN
- HARDER TO OBTAIN DESIRED PERFORMANCE
- RESPONSE LAG
- WORSE THAN PREVIOUS RUN (I.E. CASE 2C-12-1)

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-3	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_z : ON ω_z = 1.5 SPEED HOLD ; ON OLD CASE NO. : 84	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-4-10 / C	ε_{long} = .063 σ_{long} = .636 ε_{lat} = -.180 σ_{lat} = .194	4.5

COMMENTS :

- MORES RESPONSIVE THAN PREVIOUS RUN (I.E. CASE 2C-12-2)
- PROMINANT ANNOYING LONGITUDINAL VIBRATION
- DID NOT FEEL HE DID AS WELL AS HE COULD HAVE
- DID NOT CAPITALIZE ON IMPROVED RESPONSIVENESS

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-4	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; OFF OLD CASE NO. : 90	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-1 / C	ε_{long} = .045 σ_{long} = .70 ε_{lat} = -.15 σ_{lat} = .169	4

COMMENTS :

- MINOR DEFICIENCES BUT CAN COMPLETE TASK
- HAD TO WORK HARD
- HAD TO LEAD TARGET
- FELT HE COULD DO BETTER THAN HE DID

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-5	η_y : OFF ω_y = - SCAS : ON K_q = 2.0 η_z : OFF ω_z = - SPEED HOLD ; ON OLD CASE NO. : 90B	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-11 / C	ε_{long} = -.019 σ_{long} = .53 ε_{lat} = -.030 σ_{lat} = .153	4

COMMENTS :

- HAD TO WORK SOME
- THIS CASE ALLOWS PILOT TO BE MORE AGGRESSIVE IN BOTH AXES
- CAN INPUT SHARPER INPUTS WITHOUT EXCITING PIO
- CAN LOCK ON TARGET BETTER

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-12-6	η_y : ON $\omega_y = 2.0$ SCAS : OFF K_q = - η_z : ON $\omega_z = 2.0$ SPEED HOLD ; OFF OLD CASE NO. : 114	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-11-10/ / C	ε_{long} = N/A σ_{long} = N/A ε_{lat} = N/A σ_{lat} = N/A	N/A

COMMENTS :

- PILOT INPUT CAUSES INSTABILITY; OBVIOUS PIO
- VERY LIGHT STICK FORCES REQUIRED TO MAINTAIN STABILITY
- NOTE : NO TAPED DATA ; NO STRIP CHARTS

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-21-1	η_y : ON ω_y = 2.0 SCAS : ON K_q = 2.0 η_x : ON ω_x = 1.0 SPEED HOLD ; ON OLD CASE NO. : 81	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-3-7 / C	ε_{long} = -.042 σ_{long} = .744 ε_{lat} = -.385 σ_{lat} = .269	4

COMMENTS :

- WAS MORE AGGRESSIVE THAN PREVIOUS RUN

- NOTICED OVERSHOOT IN PITCH

- MORE AGGRESSIVE IN AILERON INPUTS

- IGNORED DISPLAY MOTION OF HORIZON.
  DID NOT AFFECT PERFORMANCE

Table A.8 - Data Summary Sheets continued

CASE NO.	SPECS :	
2C-21-1	η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.0$ SPEED HOLD ; ON OLD CASE NO. : 81	
RUN/PILOT	SCORES :	COOPER-HARPER RATING
6-6-10 / C	$\varepsilon_{long} = .024$ $\sigma_{long} = .64$ $\varepsilon_{lat} = -.17$ $\sigma_{lat} = .275$	6

COMMENTS :

- FELT MOTION HELPED IN THIS CASE

- NO MOTION ALLOWS STEADIER STICK INPUTS

- FELT HE COULD BE MORE AGGRESSIVE,
  BUT STILL TRIED TO STAY SMOOTH

Table A.8 - Data Summary Sheets continued

CASE NO. 2C-21-2	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 2.0$ SPEED HOLD ; ON OLD CASE NO. : 99	
RUN/PILOT 6-6-8 / C	SCORES : $\varepsilon_{long} = .142$ $\sigma_{long} = .544$ $\varepsilon_{lat} = -.096$ $\sigma_{lat} = .21$	COOPER-HARPER RATING 4

COMMENTS :

- CAN GET AGGRESSIVE AND THINGS DO NOT GET OUT OF CONTROL
- NO PIO TENDENCY
- CAN NOT TELL IF MOTION AFFECTS PERFORMANCE
- FELT SCORES MAY NOT REFLECT PERFORMANCE
- HAD TO SUPPLY SOME LEAD

Table A.8 - Data Summary Sheets continued

CASE NO. 2C-21-3	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_z : ON $\omega_z = 1.5$ SPEED HOLD ; ON OLD CASE NO. : 100	
RUN/PILOT 6-6-9 / C	SCORES : $\varepsilon_{long} = .061$ $\sigma_{long} = .60$ $\varepsilon_{lat} = -.17$ $\sigma_{lat} = .185$	COOPER-HARPER RATING 5

COMMENTS :

- MORE SQUIRRELY IN ROLL THAN IN PREVIOUS RUN

- NOTICED OVERSHOOTS IN PITCH AND ROLL (MORE NOTICEABLE IN ROLL)

- CAN NOT TELL THE EFFECT OF MOTION ON PERFORMANCE

Table A.8 - Data Summary Sheets concluded

CASE NO. 2C-21-4	SPECS : η_y : ON $\omega_y = 2.0$ SCAS : ON $K_q = 2.0$ η_x : ON $\omega_x = 1.0$ SPEED HOLD ; OFF OLD CASE NO. : 93C	
RUN/PILOT 6-4-5 / A	SCORES : $\varepsilon_{long} = .015$ $\sigma_{long} = .968$ $\varepsilon_{lat} = -.244$ $\sigma_{lat} = .259$	COOPER-HARPER RATING N/A

COMMENTS :

Appendix 6
Simulator Frequency Response Data

This appendix presents frequency response data of the simulation facility that was used to conduct the simulation experiment, i.e. the Langley VMS simulator. This data was obtained experimentally using several sets of vehicle dynamics that correspond to varying degrees of structural flexibility. The following tables describe the experimental conditions and the data that was recorded. The units for the frequency response plots are indicated as well as a description of the parameters that were measured and their units. The values of the symmetric and antisymmetric mode vibration frequencies are also indicated, these define the configurations associated with each set of frequency response data. This data was used to produce the frequency response plots of the simulator presented in Figures 16 through 20, which correspond to the baseline configuration, i.e. Configuration 1.

Tabulated Simulator Frequency Response Data

- Input Amplitude : 20 lbs (both axes).
- Magnitudes tabulated in decibels (dB).
- Phases tabulated in degrees.
- Frequencies are tabulated in Hz.

The table below indicates the units for the various parameters–

Table A.9 - Simulator Data : Symbol Definition

Symbol	Meaning	Units
F	pitch and roll axes input force	lbs
δ	pitch and roll axes stick deflections	in
n_z	normal acceleration	g's
n_y	lateral acceleration	g's
$\dot{\theta}$	attitude rate	$\frac{rad}{sec}$
q, p	pitch and roll rates	$\frac{rad}{sec}$

subscripts : cp - cockpit location
cmd - command to motion base

other symbols: $\hat{(\cdot)}$ - measured at motion base
$\dot{(\cdot)}$ - time derivative

Table A.10 - Simulator Data : Configuration Definition

	CONFIGURATION				
	1	2	3	4	5
ω_z (Hz)	2.0	1.5	1.0	2.0	0
ω_y (Hz)	2.0	2.0	2.0	1.5	0

Table A.11 - Simulator Data : Frequency Responses

CONFIGURATION 1 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-14.130	-38.400	-12.850	-11.830	-30.240	-64.360	-57.220	-22.190	-28.990
0.50	-13.210	-40.330	-14.890	-11.430	-27.150	-64.960	-55.250	-22.910	-30.090
0.75	-12.600	-38.370	-17.360	-12.200	-24.420	-63.160	-54.380	-21.050	-30.940
1.00	-13.470	-37.230	-18.870	-12.370	-21.910	-63.070	-54.250	-20.630	-31.940
1.25	-14.860	-35.910	-20.030	-12.550	-20.675	-63.310	-55.560	-20.480	-33.670
1.50	-16.430	-34.270	-21.220	-12.790	-19.310	-63.480	-56.960	-20.430	-35.470
1.75	-18.000	-31.820	-22.480	-13.080	-17.220	-62.890	-57.710	-19.916	-37.160
2.00	-19.690	-27.170	-30.490	-13.710	-7.570	-60.550	-57.750	-18.360	-39.420

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta   3) $\dot{theta}$ / delta

4) $\hat{nz}_{cp}$ / nz   5) $\hat{\dot{q}}$ / $\dot{theta}$

6) $\hat{nz}_{cp}$ / F   7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F   9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25   -14.130 -38.400 -12.850 -11.830 -30.240 -64.360 -57.220 -22.190 -28.990
0.50   -13.210 -40.330 -14.890 -11.430 -27.150 -64.960 -55.250 -22.910 -30.090
0.75   -12.600 -38.370 -17.360 -12.200 -24.420 -63.160 -54.380 -21.050 -30.940
1.00   -13.470 -37.230 -18.870 -12.370 -21.910 -63.070 -54.250 -20.630 -31.940
1.25   -14.860 -35.910 -20.030 -12.550 -20.675 -63.310 -55.560 -20.480 -33.670
1.50   -16.430 -34.270 -21.220 -12.790 -19.310 -63.480 -56.960 -20.430 -35.470
1.75   -18.000 -31.820 -22.480 -13.080 -17.220 -62.890 -57.710 -19.916 -37.160
2.00   -19.690 -27.170 -30.490 -13.710  -7.570 -60.550 -57.750 -18.360 -39.420
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 1 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-78.27	-60.75	-167.74	47.62	-287.10	-91.41	-173.09	-88.82	-257.60
0.50	-60.53	31.13	-244.31	20.56	-319.48	-8.83	-264.32	-3.44	-337.62
0.75	-98.01	14.62	-258.10	14.29	-341.61	-69.09	-337.72	-61.68	-43.27
1.00	-140.16	7.69	-262.58	6.67	-2.49	-125.70	-45.24	-116.11	-99.42
1.25	-176.81	3.00	-267.58	0.26	-22.38	-173.55	-106.43	-163.85	-144.26
1.50	-205.62	-1.71	-270.14	-5.05	-39.64	-212.38	-155.40	-198.85	-180.14
1.75	-229.06	-7.13	-277.31	-8.10	-57.38	-244.28	-203.74	-229.00	-209.62
2.00	-243.89	-28.03	-28.67	-8.58	-359.14	-280.51	-271.70	-265.76	-241.76

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta 3) $\dot{\text{theta}}$ / delta

4) $\hat{nz}_{cp}$ / nz 5) $\hat{\dot{q}}$ / $\dot{\text{theta}}$

6) $\hat{nz}_{cp}$ / F 7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F 9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25   -78.27   -60.75  -167.74   47.62  -287.10   -91.41  -173.09   -88.82  -257.60
0.50   -60.53    31.13  -244.31   20.56  -319.48    -8.83  -264.32    -3.44  -337.62
0.75   -98.01    14.62  -258.10   14.29  -341.61   -69.09  -337.72   -61.68   -43.27
1.00  -140.16     7.69  -262.58    6.67    -2.49  -125.70   -45.24  -116.11   -99.42
1.25  -176.81     3.00  -267.58    0.26   -22.38  -173.55  -106.43  -163.85  -144.26
1.50  -205.62    -1.71  -270.14   -5.05   -39.64  -212.38  -155.40  -198.85  -180.14
1.75  -229.06    -7.13  -277.31   -8.10   -57.38  -244.28  -203.74  -229.00  -209.62
2.00  -243.89   -28.03   -28.67   -8.58  -359.14  -280.51  -271.70  -265.76  -241.76
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 1 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-6.390	-57.180	-12.080	2.790	-43.080	-60.770	-61.560	-18.480	-26.090
0.50	-10.900	-51.700	-15.290	-7.010	-36.858	-69.600	-63.050	-25.970	-30.860
0.75	-24.260	-51.990	-16.850	-4.780	-40.610	-81.020	-81.720	-41.810	-45.540

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta 3) p / delta

4) $\hat{ny}_{cp}$ / ny 5) $\dot{\hat{p}}$ / p

6) $\hat{ny}_{cp}$ / F 7) $\dot{\hat{p}}$ / F

8) $\hat{ny}_{cmd}$ / F 9) $\dot{\hat{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
 0.25    -6.390 -57.180 -12.080   2.790 -43.080 -60.770 -61.560 -18.480 -26.090
 0.50   -10.900 -51.700 -15.290  -7.010 -36.858 -69.600 -63.050 -25.970 -30.860
 0.75   -24.260 -51.990 -16.850  -4.780 -40.610 -81.020 -81.720 -41.810 -45.540
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 1 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-195.18	-339.67	-99.08	-186.43	-65.80	-1.27	-0.06	-179.38	-261.50
0.50	-267.56	-337.96	-83.28	-215.34	-107.36	-100.85	-98.19	-260.58	-351.90
0.75	-306.44	-338.28	-76.03	-238.83	-163.54	-163.54	-186.01	-296.97	-38.54

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta   3) p / delta

4) $\hat{ny}_{cp}$ / ny   5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F   7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F   9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-195.18	-339.67	-99.08	-186.43	-65.80	-1.27	-0.06	-179.38	-261.50
0.50	-267.56	-337.96	-83.28	-215.34	-107.36	-100.85	-98.19	-260.58	-351.90
0.75	-306.44	-338.28	-76.03	-238.83	-163.54	-163.54	-136.01	-296.97	-38.54

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 2 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-14.050	-38.841	-12.960	-12.600	-31.910	-65.480	-58.920	-23.350	-30.570
0.50	-12.660	-39.600	-15.520	-13.420	-29.550	-65.670	-57.730	-23.350	-32.110
0.75	-12.460	-37.380	-18.120	-12.360	-25.710	-62.200	-56.290	-20.010	-32.640
1.00	-13.720	-35.380	-20.010	-12.970	-22.146	-62.070	-55.880	-19.630	-33.650
1.25	-15.700	-32.380	-22.880	-13.580	-18.293	-61.650	-56.870	-19.060	-35.400
1.50	-18.290	-26.720	-18.880	-13.870	-22.210	-58.870	-59.370	-17.260	-39.980
1.75	-16.820	-30.940	-19.070	-13.270	-21.370	-60.960	-57.250	-18.840	-37.330
2.00	-18.570	-33.600	-20.530	-13.960	-19.602	-66.120	-58.710	-21.550	-38.680

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta 3) $\dot{\text{theta}}$ / delta

4) $\hat{nz}_{cp}$ / nz 5) $\hat{\dot{q}}$ / $\dot{\text{theta}}$

6) $\hat{nz}_{cp}$ / F 7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F 9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25  -14.050 -38.841 -12.960 -12.600 -31.910 -65.480 -58.920 -23.350 -30.570
0.50  -12.660 -39.600 -15.520 -13.420 -29.550 -65.670 -57.730 -23.350 -32.110
0.75  -12.460 -37.380 -18.120 -12.360 -25.710 -62.200 -56.290 -20.010 -32.640
1.00  -13.720 -35.380 -20.010 -12.970 -22.146 -62.070 -55.880 -19.630 -33.650
1.25  -15.700 -32.380 -22.880 -13.580 -18.293 -61.650 -56.870 -19.060 -35.400
1.50  -18.290 -26.720 -18.880 -13.870 -22.210 -58.870 -59.370 -17.260 -39.980
1.75  -16.820 -30.940 -19.070 -13.270 -21.370 -60.960 -57.250 -18.840 -37.330
2.00  -18.570 -33.600 -20.530 -13.960 -19.602 -66.120 -58.710 -21.550 -38.680
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 2 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-75.06	-64.14	-172.70	43.61	-281.75	-95.58	-169.51	-89.74	-254.74
0.50	-63.16	24.81	-248.13	26.38	-310.74	-11.97	-262.02	-7.65	-322.98
0.75	-105.87	8.79	-261.48	14.57	-337.36	-82.51	-344.71	-76.02	-48.15
1.00	-149.02	0.38	-267.63	2.13	-1.56	-146.51	-58.21	-136.56	-109.61
1.25	-182.76	-10.24	-279.90	0.61	-27.12	-192.39	-129.78	-183.42	-157.89
1.50	-190.12	-68.17	-152.98	-1.19	-246.96	-259.49	-230.06	-250.32	-205.32
1.75	-220.04	-158.54	-244.36	-10.83	-15.51	-29.41	-119.91	-11.72	-181.11
2.00	-246.23	-170.34	-255.57	-11.81	-47.52	-68.38	-189.32	-50.28	-217.28

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta 3) $\dot{theta}$ / delta

4) $\hat{nz}_{cp}$ / nz 5) $\dot{\hat{q}}$ / $\dot{theta}$

6) $\hat{nz}_{cp}$ / F 7) $\dot{\hat{q}}$ / F

8) $\hat{nz}_{cmd}$ / F 9) $\dot{\hat{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-75.06	-64.14	-172.70	43.61	-281.75	-95.58	-169.51	-89.74	-254.74
0.50	-63.16	24.81	-248.13	26.38	-310.74	-11.97	-262.02	-7.65	-322.98
0.75	-105.87	8.79	-261.48	14.57	-337.36	-82.51	-344.71	-76.02	-48.15
1.00	-149.02	0.38	-267.63	2.13	-1.56	-146.51	-58.21	-136.56	-109.61
1.25	-182.76	-10.24	-279.90	0.61	-27.12	-192.39	-129.78	-183.42	-157.89
1.50	-190.12	-68.17	-152.98	-1.19	-246.96	-259.49	-230.06	-250.32	-205.32
1.75	-220.04	-158.54	-244.36	-10.83	-15.51	-29.41	-119.91	-11.72	-181.11
2.00	-246.23	-170.34	-255.57	-11.81	-47.52	-68.38	-189.32	-50.28	-217,28

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 2 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-6.420	-56.620	-12.150	2.480	-42.870	-60.550	-61.440	-18.420	-25.970
0.50	-11.190	-51.510	-15.290	-7.330	-36.800	-70.030	-63.280	-26.180	-31.050
0.75	-26.920	-51.980	-16.760	-4.170	-36.200	-83.070	-79.890	-44.580	-48.160

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta 3) p / delta

4) $\hat{ny}_{cp}$ / ny 5) $\dot{\hat{p}}$ / p

6) $\hat{ny}_{cp}$ / F 7) $\dot{\hat{p}}$ / F

8) $\hat{ny}_{cmd}$ / F 9) $\dot{\hat{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
 0.25   -6.420 -56.620 -12.150   2.480 -42.870 -60.550 -61.440 -18.420 -25.970
 0.50  -11.190 -51.510 -15.290  -7.330 -36.800 -70.030 -63.280 -26.180 -31.050
 0.75  -26.920 -51.980 -16.760  -4.170 -36.200 -83.070 -79.890 -44.580 -48.160
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 2 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-197.24	-311.52	-97.72	-211.87	-63.64	-0.63	-385.59	-178.42	-260.96
0.50	-267.60	-335.59	-82.72	-212.49	-108.35	-95.08	-98.67	-260.23	-351.70
0.75	-305.26	-337.88	-75.03	-304.80	-149.45	-227.94	-169.73	-292.81	-36.68

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta   3) p / delta

4) $\hat{ny}_{cp}$ / ny   5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F   7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F   9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-197.24	-311.52	-97.72	-211.87	-63.64	-0.63	-385.59	-178.42	-260.96
0.50	-267.60	-335.59	-82.72	-212.49	-108.35	-95.08	-98.67	-260.23	-351.70
0.75	-305.26	-337.88	-75.03	-304.80	-149.45	-227.94	-169.73	-292.81	-36.68

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 3 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-13.290	-41.210	-13.920	-10.570	-35.230	-65.060	-62.440	-24.210	-34.500
0.50	-11.150	-37.600	-18.670	-12.810	-26.740	-61.560	-56.560	-19.410	-31.440
0.75	-13.570	-33.750	-26.700	-13.440	-15.630	-60.750	-55.900	-18.640	-32.830
1.00	-18.100	-28.890	-14.000	-13.590	-26.530	-60.560	-58.620	-18.450	-40.280
1.25	-14.590	-33.450	-17.300	-12.860	-24.120	-60.890	-56.010	-19.010	-34.740
1.50	-15.750	-35.560	-18.990	-13.130	-22.100	-64.430	-56.850	-20.790	-35.490
1.75	-17.310	-36.670	-19.960	-13.350	-20.141	-67.310	-57.410	-22.930	-36.870
2.00	-18.780	-37.380	-20.910	-12.080	-17.830	-68.240	-57.520	-25.110	-38.290

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta   3) $\dot{\theta}$ / delta

4) $\hat{nz}_{cp}$ / nz   5) $\hat{\dot{q}}$ / $\dot{\theta}$

6) $\hat{nz}_{cp}$ / F   7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F   9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25   -13.290 -41.210 -13.920 -10.570 -35.230 -65.060 -62.440 -24.210 -34.500
0.50   -11.150 -37.600 -18.670 -12.810 -26.740 -61.560 -56.560 -19.410 -31.440
0.75   -13.570 -33.750 -26.700 -13.440 -15.630 -60.750 -55.900 -18.640 -32.830
1.00   -18.100 -28.890 -14.000 -13.590 -26.530 -60.560 -58.620 -18.450 -40.280
1.25   -14.590 -33.450 -17.300 -12.860 -24.120 -60.890 -56.010 -19.010 -34.740
1.50   -15.750 -35.560 -18.990 -13.130 -22.100 -64.430 -56.850 -20.790 -35.490
1.75   -17.310 -36.670 -19.960 -13.350 -20.141 -67.310 -57.410 -22.930 -36.870
2.00   -18.780 -37.380 -20.910 -12.080 -17.830 -68.240 -57.520 -25.110 -38.290
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 3 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-61.82	-63.38	-193.91	56.17	-153.85	-69.03	-49.58	-73.41	-138.11
0.50	-85.72	5.73	-260.82	25.70	-319.17	-54.29	-305.71	-52.22	-22.98
0.75	-144.06	-14.24	-64.04	11.72	-210.88	-146.58	-58.97	-142.86	-126.11
1.00	-123.52	-104.57	-184.68	4.72	-265.84	-223.38	-214.04	-216.20	-271.01
1.25	-150.11	-162.19	-243.65	-5.53	-345.78	-317.82	-19.54	-303.09	-92.03
1.50	-196.80	-171.39	-252.57	-12.64	-24.98	-20.82	-114.35	-0.19	-156.89
1.75	-225.14	-174.54	-257.67	-5.63	-51.63	-45.30	-174.44	-32.91	-192.89
2.00	-247.38	-177.21	-360.08	-16.10	-69.01	-80.70	-216.47	-58.18	-220.52

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta   3) $\dot{\theta}$ / delta

4) $\hat{nz}_{cp}$ / nz   5) $\hat{\dot{q}}$ / $\dot{\theta}$

6) $\hat{nz}_{cp}$ / F   7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F   9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data


```
0.25   -61.82   -63.38  -193.91   56.17  -153.85   -69.03   -49.58   -73.41  -138.11
0.50   -85.72     5.73  -260.82   25.70  -319.17   -54.29  -305.71   -52.22   -22.98
0.75  -144.06   -14.24   -64.04   11.72  -210.88  -146.58   -58.97  -142.86  -126.11
1.00  -123.52  -104.57  -184.68    4.72  -265.84  -223.38  -214.04  -216.20  -271.01
1.25  -150.11  -162.19  -243.65   -5.53  -345.78  -317.82   -19.54  -303.09   -92.03
1.50  -196.80  -171.39  -252.57  -12.64   -24.98   -20.82  -114.35    -0.19  -156.89
1.75  -225.14  -174.54  -257.67   -5.63   -51.63   -45.30  -174.44   -32.91  -192.89
2.00  -247.38  -177.21  -360.08  -16.10   -69.01   -80.70  -216.47   -58.18  -220.52
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 3 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-6.940	-51.600	-11.510	-2.110	-42.500	-60.640	-60.950	-18.270	-25.450
0.50	-11.590	-50.390	-14.650	-5.410	-36.300	-67.380	-62.540	-25.690	-30.360
0.75	-26.080	-50.740	-15.995	-2.460	-34.980	-79.270	-77.060	-42.830	-46.200

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta   3) p / delta

4) $\hat{ny}_{cp}$ / ny   5) $\dot{\hat{p}}$ / p

6) $\hat{ny}_{cp}$ / F   7) $\dot{\hat{p}}$ / F

8) $\hat{ny}_{cmd}$ / F   9) $\dot{\hat{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25    -6.940 -51.600 -11.510  -2.110 -42.500 -60.640 -60.950 -18.270 -25.450
0.50   -11.590 -50.390 -14.650  -5.410 -36.300 -67.380 -62.540 -25.690 -30.360
0.75   -26.080 -50.740 -15.995  -2.460 -34.980 -79.270 -77.060 -42.830 -46.200
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 3 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-192.34	-245.02	-98.60	-266.85	-52.32	-344.21	-343.26	-162.79	-246.90
0.50	-260.04	-323.78	-84.97	-222.31	-105.50	-86.14	-90.52	-251.72	-344.30
0.75	-299.88	-331.70	-77.60	-219.85	-146.28	-131.43	-163.76	-283.39	-34.54

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta 3) p / delta

4) $\hat{ny}_{cp}$ / ny 5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F 7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F 9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25  -192.34  -245.02   -98.60  -266.85   -52.32  -344.21  -343.26  -162.79  -246.90
0.50  -260.04  -323.78   -84.97  -222.31  -105.50   -86.14   -90.52  -251.72  -344.30
0.75  -299.88  -331.70   -77.60  -219.85  -146.28  -131.43  -163.76  -283.39   -34.54
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 4 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-14.070	-38.500	-12.950	-12.080	-28.800	-64.640	-55.820	-22.590	-27.590
0.50	-13.230	-40.540	-14.960	-10.990	-25.330	-64.760	-53.530	-22.950	-28.410
0.75	-12.550	-38.460	-17.490	-11.240	-23.110	-62.230	-53.140	-20.890	-29.800
1.00	-13.470	-37.300	-18.990	-12.270	-21.550	-63.040	-54.020	-20.550	-31.730
1.25	-14.880	-36.010	-20.160	-12.100	-20.628	-62.970	-55.670	-20.380	-33.610
1.50	-16.510	-34.350	-21.380	-12.590	-19.281	-63.430	-57.160	-20.350	-35.600
1.75	-18.100	-31.910	-22.480	-12.940	-17.550	-62.940	-58.130	-19.930	-37.390
2.00	-19.650	-27.970	-30.450	-13.610	-7.740	-60.500	-57.840	-18.380	-39.500

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta 3) $\dot{theta}$ / delta

4) $\hat{nz}_{cp}$ / nz 5) $\hat{\dot{q}}$ / $\dot{theta}$

6) $\hat{nz}_{cp}$ / F 7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F 9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-14.070	-38.500	-12.950	-12.080	-28.800	-64.640	-55.820	-22.590	-27.590
0.50	-13.230	-40.540	-14.960	-10.990	-25.330	-64.760	-53.530	-22.950	-28.410
0.75	-12.550	-38.460	-17.490	-11.240	-23.110	-62.230	-53.140	-20.890	-29.800
1.00	-13.470	-37.300	-18.990	-12.270	-21.550	-63.040	-54.020	-20.550	-31.730
1.25	-14.880	-36.010	-20.160	-12.100	-20.628	-62.970	-55.670	-20.380	-33.610
1.50	-16.510	-34.350	-21.380	-12.590	-19.281	-63.430	-57.160	-20.350	-35.600
1.75	-18.100	-31.910	-22.480	-12.940	-17.550	-62.940	-58.130	-19.930	-37.390
2.00	-19.650	-27.970	-30.450	-13.610	-7.740	-60.500	-57.840	-18.380	-39.500

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 4 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-78.74	-57.56	-167.21	49.24	-294.23	-87.06	-180.18	-87.28	-263.01
0.50	-60.85	28.80	-244.27	22.44	-323.19	-9.61	-268.27	-6.68	-344.53
0.75	-98.30	14.01	-257.98	14.45	-343.75	-69.85	-340.03	-62.85	-46.84
1.00	-140.38	7.15	-262.39	3.26	-2.44	-129.96	-45.20	-120.76	-100.40
1.25	-176.94	2.65	-267.70	0.02	-22.19	-174.27	-106.83	-164.70	-144.95
1.50	-205.62	-1.64	-269.66	-3.99	-43.97	-211.25	-159.25	-199.58	-179.99
1.75	-228.99	-7.28	-277.21	-8.62	-60.23	-244.90	-206.44	-229.42	-209.31
2.00	-244.08	-27.79	-27.75	-9.54	-1.19	-281.41	-273.01	-265.53	-241.42

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta   3) $\dot{theta}$ / delta

4) $\hat{nz}_{cp}$ / nz   5) $\hat{\dot{q}}$ / $\dot{theta}$

6) $\hat{nz}_{cp}$ / F   7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F   9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-78.74	-57.56	-167.21	49.24	-294.23	-87.06	-180.18	-87.28	-263.01
0.50	-60.85	28.80	-244.27	22.44	-323.19	-9.61	-268.27	-6.68	-344.53
0.75	-98.30	14.01	-257.98	14.45	-343.75	-69.85	-340.03	-62.85	-46.84
1.00	-140.38	7.15	-262.39	3.26	-2.44	-129.96	-45.20	-120.76	-100.40
1.25	-176.94	2.65	-267.70	0.02	-22.19	-174.27	-106.83	-164.70	-144.95
1.50	-205.62	-1.64	-269.66	-3.99	-43.97	-211.25	-159.25	-199.58	-179.99
1.75	-228.99	-7.28	-277.21	-8.62	-60.23	-244.90	-206.44	-229.42	-209.31
2.00	-244.08	-27.79	-27.75	-9.54	-1.19	-281.41	-273.01	-265.53	-241.42

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 4 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-5.550	-59.920	-12.160	4.790	-43.750	-60.680	-61.460	-18.400	-25.999
0.50	-11.420	-52.000	-14.900	-5.630	-36.880	-69.040	-63.200	-26.270	-31.050
0.75	-26.630	-52.210	-16.310	-5.980	-43.590	-84.810	-86.530	-44.030	-47.360

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta   3) p / delta

4) $\hat{ny}_{cp}$ / ny   5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F   7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F   9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-5.550	-59.920	-12.160	4.790	-43.750	-60.680	-61.460	-18.400	-25.999
0.50	-11.420	-52.000	-14.900	-5.630	-36.880	-69.040	-63.200	-26.270	-31.050
0.75	-26.630	-52.210	-16.310	-5.980	-43.590	-84.810	-86.530	-44.030	-47.360

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 4 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-179.45	-4.35	-116.22	-179.07	-63.58	-2.87	-359.24	-179.93	-261.36
0.50	-258.68	-342.05	-92.94	-221.48	-105.05	-102.22	-96.68	-258.56	-348.98
0.75	-301.21	-335.80	-82.84	-163.92	-159.34	-80.92	-183.39	-291.11	-34.49

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta 3) p / delta

4) $\hat{ny}_{cp}$ / ny 5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F 7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F 9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25  -179.45    -4.35  -116.22  -179.07   -63.58    -2.87  -359.24  -179.93  -261.36
0.50  -258.68  -342.05   -92.94  -221.48  -105.05  -102.22   -96.68  -258.56  -348.98
0.75  -301.21  -335.80   -82.84  -163.92  -159.34   -80.92  -183.39  -291.11   -34.49
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 5 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-14.260	-38.090	-12.680	-11.640	-28.870	-63.970	-55.800	-21.760	-27.600
0.50	-13.790	-41.380	-14.280	-10.930	-25.570	-66.080	-53.640	-24.140	-28.490
0.75	-12.890	-39.620	-16.710	-11.370	-23.510	-63.870	-53.110	-21.720	-29.760
1.00	-13.510	-39.280	-18.190	-10.450	-22.220	-63.230	-53.920	-21.930	-31.440
1.25	-14.560	-39.120	-19.230	-12.170	-21.890	-65.830	-55.670	-22.630	-33.040
1.50	-16.040	-39.080	-20.080	-13.220	-21.680	-68.320	-57.790	-24.060	-34.900
1.75	-17.460	-39.020	-20.690	-11.540	-20.704	-68.010	-58.850	-25.430	-36.520
2.00	-18.710	-39.000	-21.300	-12.670	-19.376	-70.380	-59.390	-26.660	-37.940

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta   3) $\dot{\theta}$ / delta

4) $\hat{nz}_{cp}$ / nz   5) $\hat{\dot{q}}$ / $\dot{\theta}$

6) $\hat{nz}_{cp}$ / F   7) $\hat{\dot{q}}$ / F

8) $\hat{nz}_{cmd}$ / F   9) $\hat{\dot{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25   -14.260 -38.090 -12.680 -11.640 -28.870 -63.970 -55.800 -21.760 -27.600
0.50   -13.790 -41.380 -14.280 -10.930 -25.570 -66.080 -53.640 -24.140 -28.490
0.75   -12.890 -39.620 -16.710 -11.370 -23.510 -63.870 -53.110 -21.720 -29.760
1.00   -13.510 -39.280 -18.190 -10.450 -22.220 -63.230 -53.920 -21.930 -31.440
1.25   -14.560 -39.120 -19.230 -12.170 -21.890 -65.830 -55.670 -22.630 -33.040
1.50   -16.040 -39.080 -20.080 -13.220 -21.680 -68.320 -57.790 -24.060 -34.900
1.75   -17.460 -39.020 -20.690 -11.540 -20.704 -68.010 -58.850 -25.430 -36.520
2.00   -18.710 -39.000 -21.300 -12.670 -19.376 -70.380 -59.390 -26.660 -37.940
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 5 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-81.55	-57.26	-163.58	47.94	-291.24	-90.86	-176.36	-89.74	-260.14
0.50	-59.27	38.60	-240.33	22.02	-322.59	-358.66	-262.20	-356.88	-337.54
0.75	-92.29	20.60	-254.94	7.80	-342.59	-63.89	-329.63	-55.50	-35.94
1.00	-133.93	14.82	-259.46	10.26	-1.51	-108.85	-34.89	-107.36	-88.92
1.25	-172.83	11.57	-262.19	-2.71	-20.67	-163.96	-95.69	-151.73	-135.47
1.50	-203.78	9.31	-263.67	-14.44	-31.69	-208.90	-139.14	-186.42	-171.71
1.75	-227.48	8.37	-264.80	-15.36	-52.99	-234.46	-185.26	-212.26	-198.81
2.00	-246.53	6.94	-266.07	-29.69	-72.02	-269.28	-224.62	-233.44	-221.53

key : All longitudinal axis parameters

1) delta / F

2) nz_{cp} / delta 3) $\dot{theta}$ / delta

4) $\hat{nz}_{cp}$ / nz 5) $\dot{\hat{q}}$ / $\dot{theta}$

6) $\hat{nz}_{cp}$ / F 7) $\dot{\hat{q}}$ / F

8) $\hat{nz}_{cmd}$ / F 9) $\dot{\hat{q}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25   -81.55   -57.26  -163.58   47.94  -291.24   -90.86  -176.36   -89.74  -260.14
0.50   -59.27    38.60  -240.33   22.02  -322.59  -358.66  -262.20  -356.88  -337.54
0.75   -92.29    20.60  -254.94    7.80  -342.59   -63.89  -329.63   -55.50   -35.94
1.00  -133.93    14.82  -259.46   10.26    -1.51  -108.85   -34.89  -107.36   -88.92
1.25  -172.83    11.57  -262.19   -2.71   -20.67  -163.96   -95.69  -151.73  -135.47
1.50  -203.78     9.31  -263.67  -14.44   -31.69  -208.90  -139.14  -186.42  -171.71
1.75  -227.48     8.37  -264.80  -15.36   -52.99  -234.46  -185.26  -212.26  -198.81
2.00  -246.53     6.94  -266.07  -29.69   -72.02  -269.28  -224.62  -233.44  -221.53
```

Table A.11 - Simulator Data : Frequency Responses continued

CONFIGURATION 5 : Magnitudes

freq	1	2	3	4	5	6	7	8	9
0.25	-6.490	-54.870	-13.990	0.050	-41.770	-61.300	-62.240	-19.100	-26.740
0.50	-12.370	-51.470	-16.920	-8.950	-36.930	-72.790	-66.220	-28.480	-33.730
0.75	-39.460	-51.910	-18.970	5.590	-35.340	-85.770	-93.780	-58.480	-62.210

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta   3) p / delta

4) $\hat{ny}_{cp}$ / ny   5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F   7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F   9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

0.25	-6.490	-54.870	-13.990	0.050	-41.770	-61.300	-62.240	-19.100	-26.740
0.50	-12.370	-51.470	-16.920	-8.950	-36.930	-72.790	-66.220	-28.480	-33.730
0.75	-39.460	-51.910	-18.970	5.590	-35.340	-85.770	-93.780	-58.480	-62.210

Table A.11 - Simulator Data : Frequency Responses concluded

CONFIGURATION 5 : Phases

freq	1	2	3	4	5	6	7	8	9
0.25	-236.74	-300.30	-59.71	-189.32	-70.17	-6.36	-6.62	-184.30	-267.87
0.50	-286.22	-329.91	-64.90	-232.36	-129.92	-128.48	-121.04	-268.65	-4.06
0.75	-306.74	-330.99	-64.16	-140.25	-6.56	-57.97	-17.46	-282.70	-44.36

key : All lateral-directional axes parameters

1) delta / F

2) ny_{cp} / delta　　3) p / delta

4) $\hat{ny}_{cp}$ / ny　　5) $\hat{\dot{p}}$ / p

6) $\hat{ny}_{cp}$ / F　　7) $\hat{\dot{p}}$ / F

8) $\hat{ny}_{cmd}$ / F　　9) $\hat{\dot{p}}_{cmd}$ / F

the data below is for easy reading into fortran programs

data

```
0.25  -236.74  -300.30   -59.71  -189.32   -70.17    -6.36    -6.62  -184.30  -267.87
0.50  -286.22  -329.91   -64.90  -232.36  -129.92  -128.48  -121.04  -268.65    -4.06
0.75  -306.74  -330.99   -64.16  -140.25    -6.56   -57.97   -17.46  -282.70   -44.36
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Volume One—Experiment, Results and Analysis

16. Abstract

The simulation experiment described herein addresses the effects of structural flexibility on the dynamic characteristics of a generic family of aircraft. The simulation was performed using the NASA Langley VMS simulation facility. The vehicle models were obtained as part of this research project. The simulation results include complete response data and subjective pilot ratings and comments and so allow a variety of analyses. The subjective ratings and analysis of the time histories indicate that increased flexibility can lead to increased tracking errors, degraded handling qualities, and changes in the frequency content of the pilot inputs. These results, furthermore, are significantly affected by the visual cues available to the pilot.

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